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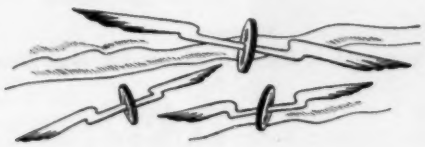

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STRENGTHS OF BRICK AND OTHER STRUCTURAL SILICATES[1]

By John H. Griffith[2]

ABSTRACT

It is found from a survey of the important researches on building stones and heavy clay products in the last fifty years that the strength data may be formulated by the law

$$p = c \frac{S}{A + A_0} (1 \pm e),$$

where p = stress at rupture
c = efficiency or relation factor
S = parameter of dimensions stress
A = per cent of sensible pore space determined by degree of absorption of water by weight
A_0 = parameter, taking account of the insensible or colloidal pore space
e = probable error for a single datum

The working law obtained where it was possible to place the data on a strict mechanical parity is

$$p = \frac{80{,}000}{A + 4} (1 \pm 0.25)$$

for the compression strengths and a conservative value of $^1/_6$ of this amount for the modulus of rupture, the latter varying from $^1/_6$ to $^1/_4$ depending upon the particular technique of tests. The probable error has been selected at ± 0.25 but is usually smaller, this also being conditioned by manipulative technique. It is $^1/_2$ this amount for five tests and $^1/_3$ for ten tests, the variations now existing being considerably reduced by precise methods of testing.

I. Introduction

It was shown a century ago by Whewell in his Philosophy of the Inductive Sciences (1837) that progress in research is attainable only in the degree that investigators are able to introduce organizing conceptions in their interpretations of observed scientific data. A large volume of data has accumulated since the advent of the testing machine for the strengths of the heavy silicate products used in engineering. In this category are the building stones of igneous, sedimentary, and metamorphic origins, including limestones, quartzites, and sandstones as limiting cases; paving, building, refractory, and sand-lime brick; tile of various descriptions and sewer pipe; glassware, abrasives, electrical insulators, and terra cottas among the important products. In the light of Whewell's conception it is pertinent to ask whether or not data of this kind are organizable and whether or not the correlations can be effected in a simple rational manner suitable for engineers and ceramists. Facts and conclusions are submitted in support

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio. February, 1931 (Heavy Clay Products Division). Received December 23, 1930.

[2] Professor of Experimental Engineering, Iowa State College, Ames, Iowa.

of the statement that for a permissible range of variation in practice simple precise relations may be found for the strengths of such materials where the determinate data are available.

II. The Argument for the Theory

It is known from physical chemistry[3] that if matters are placed upon a strict mechanical parity in conducting physical tests cognizance must be taken of the initial pressures, volumes, and temperatures of the specimens, their chemical compositions, densities, and lattice structures among the important variables, not all of which are independent. The three first variables mentioned, neglecting minor variations, may be regarded on a parity in the case of the statistical evidence to be submitted. The compositon of the system lime–alumina–silica (+Mg, Fe, Na, K, etc.) will be considered in the light of a mean for the classes of materials presented. The density is tacitly considered the fundamental variable of the entire silicate group. The physical structures of specimens will be regarded chaotic or amorphous in all cases, the effects of such laminations and surface treatments as exist for ceramic materials being well within the range of the probable errors discussed. There may be some degree of atomic organization in the case of annealed glasses and the vitrified clays resulting in the dense rhombohedral or cubic packings;[4] the behaviors will be regarded isotropic, two moduli being implied out of a possible five, as warranted in the light of the data to be considered.

In the general polytropic[5] pressure-volume relation for the compression of matter, pv^n = constant, it was shown by Kelvin[6] that a potential function,[7] one satisfying Laplace's equation, exists in the case of isentropic

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[3] E. W. Washburn, Physical Chemistry, Chapter 24, etc.

[4] E. A. H. Love, Mathematical Theory of Elasticity, 2nd ed., pp. 154–57.

[5] Marks, Mechanical Engineers' Handbook, 1st ed., p. 317.

[6] Love, *op. cit.*, p. 93.

[7] The fundamental point of the argument involves the idea of dependency upon density gradients in the case of the straining or rupture of matter exposed to a field of pressure as from a testing machine: it cannot be displaced to a region already occupied if it is incompressible. Stress is mechanical resistance to displacement and is the greater the denser the material under compression. In general, the flow of an entity, heat, electricity, matter, or other forms of energy, is at right angles to the surfaces of temperature, potential, density, or other scalar quantity involved, and is proportional to the gradient or steepest slope of the scalar or intensity factor of the entity under consideration. In the case of a topographical map, to illustrate, the surfaces reduce as a special case to contours of equal elevation which the "rivers" cross orthogonally. The flows are proportional in this case to the hydraulic gradients found by dividing the vertical distances between neighboring contours by the corresponding horizontal distances and passing to the limits as the contours are brought closer and closer to the points of coalescence: formulated $\lim_{\Delta n = 0} \frac{\Delta V}{\Delta n} = \frac{\partial V}{\partial n}$. In the case of heat transmitted through a conduc-

(adiabatic) or very rapid compressions, where $n = k$, the ratio of the specific heat at constant pressure to that at constant volume, also for isothermal compressions, where $n = k = 1$, giving the Boyle Mariotte law, $pv = c$, for moderate rates of compression. Newton[8] found the Boyle-Mariotte law to fail when applied to the case of sound transmission through air: Laplace showed, however, that a concordant theory existed when using the more general relation $pv^k = c$; indeed, the scientist deduces the ratio, k, experimentally by the measurements of the rates of sound transmission through helium, air, and other gases. In the case of the crystalline phases of matter on the other hand, and also for various liquid phases, where the specific heat ratio, k, is nearly unity, varying from 1.0006 to 1.010 for the glasses and metals,[9] there is little difference whether the rate of compression is fast or slow: thus the Boyle-Mariotte law, $pv = c$, the temperature constant, suffices for the type of expression to consider in the case of the compression of the heavy silicates used in industry.

Dr. Harry Bateman[10] calls the isothermal law, $pv = c$, the first law of elasticity. It is not only the first historically, but the first dynamically, as a few illustrations will attest. If, as an example, the pressure is plotted against $\frac{\Delta v}{v_0}$, the strain or change of volume per initial volume, the relation is linear for small compressions, a restatement of Hooke's law of the theory of elasticity. Taking a unit tube of force traversing a field of potential surfaces orthogonally[7] and multiplying strain by the pressure along the axis of the tube at constant entropy or constant temperature there is ob-

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tor by Fourier's well-known law (see Wilson, Advanced Calculus, p. 533 for good examples), the quantity flowing is $Q = c\frac{\partial T}{\partial n}$, where c is a constant appropriate to the conductor and $\frac{\partial T}{\partial n}$ is the temperature gradient, a particular case of the law of Laplace for the flow of "incompressible fluids," where there is no rotation or eddying existing to modify the statement of the law.

The late Dean J. B. Johnson has remarked apropos (Modern Framed Structures, 1st ed., p. 220) that when there are two or more paths for a load to travel in a stress conductor it will divide itself in proportion to the "rigidities," which are inversely as the displacements or "deflections" of the material in question. Thus the more rigid or dense the matter the greater will be the mechanical resistance set up before the chemical or atomic attractions and repulsions are overcome at rupture of the mass. The general theory of elasticity gives also the analysis for compressible matter, the general potential theory being applicable but not needed in the treatment of brittle materials such as are considered (see E. A. H. Love, *op. cit.*, p. 218).

[8] Watson, Textbook of Physics, 5th ed., pp. 364–65.

[9] Kelvin, quoted in John Perry's Applied Mechanics, p. 317.

[10] Encyclopedia Britannica, Harry Bateman, article on Elasticity, 14th ed. Also see Kelvin, Encyclopedia Britannica, article on Elasticity, 9th ed., and Maxwell, Theory of Heat.

tained an element of the Green elastic potential.[11] Summing such expressions along the coördinate axes to give the general homogeneous quadratic function denoting the potential and differentiating with respect to strain components gives the stresses in crystals and other heterotropic structures. Again the product of pressure by volume from Regnault's[12] experiments is work, just as pressure by strain per unit of volume in the potential theory is work, the temperature or the entropy being constant. From the *a priori* considerations it seems reasonable to apply the Boyle-Mariotte relation to the interpretation of the straining and rupture of the silicates.

The *a posteriori* evidence from the mechanical archives is not altogether conclusive. If the hammer of a Shore scleroscope is conceived a piston and the aforementioned tube of stress between neighboring potential surfaces is regarded to be the "working substance," the height of rebound of the hammer is a measure of the hardness, and this when plotted with the Brinell or indentation hardness gives a straight line as shown for heat-treated alloy steels by the researches of Abbott.[13] Rectifying the Boyle-Mariotte equation, $pv = c$, by the substitution, $v = m/d$ (m = mass and d = density), there results the new relation $p = c_1 d$, whence it might be assumed for a hard alloy steel that resistance to pressure is proportional to density, whereas actually the weight of the steel is practically constant. The heat treatment, however, involves a theory of chemical friction which is quite foreign to the ideas of Boyle and Mariotte. It is related by Tait[14] that both these authorities used sponges, wool, hair, and other fibrous materials as well as air in their experimental deductions of the $pv = c$ law, temperature constant: one may also conceive the ceramist's silicates as dispersed networks of fibrillae and intervening pores, differing not in kind but in degree of displacement from the others; in the former highly compressible matters finite strains occur, in the latter they are infinitesimal. Boyle was quite explicit in considering air to possess the nature of a "spring." His term "elastical" is in fact the prototype of the modern word "elastic."[15]

The actual behaviors of elastic matters suggest the Boyle-Mariotte type of law for consideration in a number of cases. All of the curves of the silicates to be given later in the paper are quasi-equilateral hyperbolas. The late Dean J. B. Johnson[16] found curves approximating hyperbolas in representing the pressure-moisture relations for timber; Campbell[17]

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[11] E. A. H. Love, *op. cit.*, Chapt. III.

[12] G. C. V. Holmes, The Steam Engine, 7th ed., p. 74.

[13] R. R. Abbott, *Proc. A.S.T.M.*, 15 [2], 42 (1915).

[14] P. G. Tait, Properties of Matter, p. 307.

[15] Encyclopedia Britannica, H. Bateman, article on Elasticity, 14th ed.

[16] J. B. Johnson, Materials of Construction, 4th ed., p. 668.

[17] *Ibid.*, 7th ed., pp. 653–54.

found them for steel densified by rolling. Eliminating the volume in the polytropic law, $pv^n = c$, by the previously given substitution to give $p = c_2 d^n$, c_2, a new constant and d, the density, the U. S. Forest Products Laboratory[18] found the latter equation to hold for the complete range of timber, when n was of the order 1.2 to 1.3. Abram's law for Portland cement concrete[19] consisting of calcium silicates and calcium aluminates in various proportions, $p = \frac{14{,}000}{7^{w/c}}$ (w, the water volume and c, cement by volume), may seem anomalous in character: developing $7^{w/c}$ by Maclaurin's theorem, however, there will be found the same type of equation, $p = c\frac{14{,}000}{kw + c}$, to be proposed presently if the cement content c is treated as parameter, higher orders being rejected.

The ceramist may dispense with a separate chemical affinity or cohesion term in his working equation for the silicates if he takes cognizance of the fact, fairly confirmed in the opinions of several scientists,[20] that the higher order attractions in the force, series $\sum \frac{1}{r^n}$, become effective with condensation of the atomic lattices as compared with particular lower order terms when the particles approach closer and closer. It is known that paving brick and the glasses are actually toughened by the process of densification and annealing, care being taken to avoid the submicroscopic bubbles injuring the structures.[20] Orton[21] has shown that the pore space determined by the amount of water that the material will absorb is a measure of the degree of vitrification. Since there is a paucity of systematic strain and hardness data in the case of the silicates, it would seem appropriate to carry Orton's idea to its logical conclusion assuming as a working hypothesis that the strength of a silicate is a function of its absorption percentage. The extent to which this can be done in the case of existing data remains to be demonstrated. The applicability of the laws found to the case of future data will be conditioned by manipulative efficiency. This will also be discussed.

III. Rational Law for Strengths of Silicate Products

In the Boyle-Mariotte law, $p = cd$, temperature constant, let $d = \frac{k}{A + A_0}$, where k = a new constant and A and A_0 = the sensible and insensible

[18] J. B. Johnson, Materials of Construction, 7th ed., p. 212.

[19] *Ibid.*, 6th ed., p. 816.

[20] Osborne Reynolds, Collected Works, Vol. III, p. 6. Henri Poincare, Value of Science, p. 92. Albert C. Crehore, Mystery of Matter and Energy, Chapter 8.

[21] Edward Orton, Jr., *Proc. A.S.T.M.*, **15**, 245 (1915).

("colloidal") pores, respectively, $ck = S$, having the dimensions stress in the resultant formula $p = \frac{S}{A + A_0}$. As the total pores, $A + A_0$, increase to the volume of the specimen, v, the stress and density will approach the limit zero as practically fulfilled for soft sponge rubber and air. If the total pores $A + A_0$ could ultimately become zero the stress would increase without limit as in the older ether conceptions. If A is the variable the stress and density will not have to be considered infinite because the "colloidal" bubbles, which are individually submicroscopic, will occupy finite space in the aggregate and will be represented by the volume A_0. Thus, if $A + A_0$ at constant temperature is the variable, the equation, $p(A + A_0) = S$, is a modified Boyle-Mariotte law still represented throughout the whole domain by an equilateral hyperbola but with a different volume and constant. Whereas regarding A alone the variable, one is merely taking the same liberties with the volume that Navier[22] took with the pressure, namely, adding a parameter or "variable-constant," in this case A_0, and for the same expedient, the maintenance of a suitable congruence with experimental data. The formula will be considered.

IV. The Absorption as the Fundamental Variable

Since General Quincy A. Gillmore's tests on building stones in 1875, investigators have obtained absorption data on practically all classes of materials possessing finite pores. The data are in the records but no attempt seems to have been made to organize them quantitatively.[23] It is unfortunate to this end that the "rough and ready" method of procedure has too often had precedence over the scientific method in the experimental determinations. Merrill,[24] who records General Gillmore's data, remarks of building stone data generally that "there is a most remarkable increase by the later results probably due to refinements of method." The late Dean J. B. Johnson[25] remarks likewise of his tests on paving brick: "The absorption test has been made by drying on top of boilers and then soaking 24 hours. While these intervals are not long enough to give absolute results, they serve very well for commercial purposes." The late Waldemar Voigt[26] of Goettingen, international authority on the structures and tests of crystals, states with reference to the technique of tests: "We need above all more systematic observations under conditions which are prescribed, not by technical needs, but rather by the scientific point of

[22] G. C. V. Holmes, *op. cit.*, p. 127.

[23] See J. H. Griffith, "On the Strength of Heavy Clay Products," *Jour. Amer. Ceram. Soc.*, **8** [2], 108 (1925).

[24] G. P. Merrill, Stones for Building and Decoration, 3rd ed., p. 497.

[25] Johnson's Materials of Construction, 4th ed., p. 661.

[26] *Ann. Physik*, Ser. 4, Bd. 4 (1901).

view." Fortunately, the occasional lapses from the scientific technique made by investigators in the past reveal themselves in comprehensive statistical studies. An effort has been made to point them out and discount them in this paper in certain cases.

V. Importance of Realizing High-Strength Efficiencies

Two objectives were kept in mind on the preliminary tests on brick made to obtain the parameters S and A_0 of the equation $p = \frac{S}{A + A_0}$. The first aim was to obtain the highest efficiencies possible in strength-absorption data in conformity with the recommendation of Voigt, solely as the norm of comparison, and quite regardless of whether this would be of interest to technologists or of direct use in practice. The manufacturer should know the possibilities of his products as well as the scientist. To illustrate, Dr. H. H. Sheldon[27] has stated that technologists are getting some 8 or 10% of the potential strengths for steel: they get, as an example in the case of piano wire, some 400,000 pounds per square inch; he claims they should be getting 5,000,000 pounds per square inch. The Russian authority, Dr. Abram Joffé,[28] a collaborator of Roentgen, recently showed one of the reasons for the discrepancies between theory and practice: he realized 0.04% of the theoretical lattice strength on a test of a rock salt crystal which he interpreted as due to the incipient surface cracks; when he tested his specimens under water to seal the divellent furrows which started the stress infinities, he obtained an order of 75% of the lattice strengths, a very fair amount in the present state of investigation. Suppose the ceramist does obtain 100% efficiency: he can always rate a "commercial" or approximate test by means of what the physicist calls a "weight," and thus have correct comparisons, as in the case of pumps and engines. This is impossible at the present time because of the promiscuous character of the data on record.

In the second objective it seemed desirable to keep the zones of plotted data as narrow as practicable thus insuring consistently small probable errors or standard deviations from the median curve defining the derived law. There is, of course, in practice an irreducible limit which cannot be minimized in testing brittle materials, seemingly fortuitous aspects which cannot be eliminated on account of the numerous minor variables.

VI. Description of Preliminary Tests on Brick

If it is possible to test the heavy structural silicates as a group, having a single average chemical composition, as is tacitly done in the iron-carbon group of metallurgy as an example, the investigation of a single commodity

[27] Pocket Library of World's Essential Knowledge, Vol. IV, Part II, p. 17.

[28] Abram Joffé, Physics of Crystals, 1928.

should show it if a comparison is made with the historical data now in existence. There should be no need, if this can be done, of meticulously profound studies of the types of clays and method of manufacture any more than a bridge engineer differentiates to any great extent between rolled and riveted steels in fabricating girders. Foresters used to make distinctions thirty years ago between the relative qualities of long-leaf and short-leaf southern pines. Now they consider density factors largely, such as percentages of summer and spring wood, the number of rings per inch, the moisture content, etc. Pursuant to this viewpoint, tests of the one class of Iowa brick selected have been deemed sufficient for fixing the general law without recourse to studies on chemical, colloidal, textural, and other qualities. The rôle of the latter is within the range of probable error that it is possible to obtain with present-day instrumentation.

The stress-absorption data found for the special series of Iowa brick are recorded in Table I after the manner of Committee C3 of the American Society for Testing Materials.[29] They are also plotted in Fig. 1 for comparison with the results on the other silicate commodities tested by the various authorities to be mentioned. The brick were tested in general conformity with the recommendations of the Committee with the following modifications appropriate to the objectives of the paper. In the modulus of rupture determinations, to avoid surface irregularities, the bearing surfaces top and bottom were "capped" with smooth cold-rolled steel bars, 1 inch by $^5/_{16}$ inch, set in plaster of Paris. Since the modulus of rupture is a function of the span between supports[30] the latter were taken 7 inches apart in all cases to maintain volume parity. Since twists may occur from nonuniform distributions of loads on upper surfaces of brick, this tendency was corrected by having the V-shaped loading head slightly concave upward toward the axis of the testing machine, the thin crescent-shape beam of light revealed to observer, affording a means of securing a symmetrical pressure distribution on the center line of brick. The loads were applied at an adjusting speed of about $^5/_{10}$ inch per minute and at 500 to 700 pounds were reduced to the testing speed of 0.05 inch per minute. The brick were oven-dried and measured to 0.01 inch. Four calibrations of the 60,000-lb. testing machine (Olsen) showed it be correct to within $^3/_{10}$ of 1% of the applied weights.

In getting the absorption percentage, the maximum amount is desired, together with uniformity in measurement, it being found in one case that as much as 4% was absorbed while the brick were cooling in hot water after soaking and boiling. The half-brick from transverse tests to this end were

[29] *Proc. A.S.T.M.*, **14** [1], 188 (1914).

[30] See discussion of paper, "On the Flexure of Heavy Beams Subjected to Continuous Systems of Load," *Quarterly Jour. Mathematics*, pp. 63–110 (1889), by Prof. Karl Pearson.

TABLE I

RESULTS OF TESTS OF BUILDING BRICK FROM IOWA CLAYS

Compression Tests Made on Edge with Ground Faces. Transverse Tests Made Flatwise. Supports 7 Inches Apart. Plaster of Paris Bedments

Serial No.	Compression strength (lb./sq. in.)	Modulus of rupture (lb./sq. in.)	Absorption by weight (%)	Remarks
1	10,700	1260	6.00	Carboniferous shale
2	5,170	1678	3.84	" "
3	14,840	2340	1.50	" "
4	4,980	1073	8.07	" "
5	12,960	2440	4.85	" "
6	6,700	3280	0.40	" "
7	12,500	2700	2.98	" "
8	7,260	812	8.48	" "
9	8,080	1997	5.98	" "
10	12,730	1151	6.64	" "
11	10,910	2313	4.46	" "
12	18,770	2705	1.60	" "
13	9,080	1760	7.15	" "
14	13,910	2783	5.90	" "
15	8,930	2125	4.84	" "
16	14,240	1720	4.56	" "
17	14,500	2295	3.01	" "
18	17,400	1355	3.11	" "
19	9,500	2037	3.32	" "
20	8,770	1760	4.60	" "
21	12,500	1925	2.92	" "
22	9,100	1740	4.78	" "
23	11,170	2430	2.47	" "
24		1780	8.74	" "
25	10,900	1332	8.87	" "
26	10,140	1598	9.85	" "
27	10,440	1530	8.67	" "
28	7,520	1650	5.66	" "
29	9,950	2010	5.03	" "
30	7,230	1800	1.59	" "
31	9,780	2360	1.62	" "
32	9,500	2210	1.68	" "
33	6,030	2280	1.62	" "
34	6,450	453	13.73	" "
35	6,300	685	13.58	" "
36	7,280	1140	13.53	" "
37	9,420	1002	9.18	" "
38	9,700	652	8.40	" "
39	7,420	1868	7.04	" "
40	7,850	1880	6.65	" "
41	7,320	637	8.58	" "
42	10,000	1328	8.45	" "
43	8,470	1625	7.21	" "
44	10,100	1525	3.70	" "
45	9,150	2137	6.17	" "
46	8,780	1662	6.83	" "
47	6,350	1795	6.35	" "
48	7,850	1632	4.87	" "
49	6,770	1248	7.52	" "
50	7,390	873	7.62	" "
51	5,400	1070	8.06	" "
52	8,490	1224	4.04	" "
53	(lost)	1572	4.10	" "
54	8,855	1483	2.42	" "
55	7,650	1619	5.27	" "
56	7,030	1172	5.74	" "

TABLE I (*continued*)

Serial No.	Compression strength (lb./sq. in.)	Modulus of rupture (lb./sq. in.)	Absorption by weight (%)	Remarks
57	9,630	1175	5.91	Carboniferous shale
58	10,230	1441	7.38	" "
59	7,575	1675	7.14	" "
60	6,760	1223	8.62	" "
61	7,310	1656	4.87	" "
62	10,100	1229	3.30	" "
63	6,730	1293	5.48	" "
64	7,650	1728	3.96	" "
65	5,030	1682	7.76	" "
66	11,180	1448	3.92	" "
67	7,610	1612	4.44	" "
68	10,000	1425	3.68	" "
69	5,820	1740	6.00	" "
70	8,925	1985	3.15	" "
71	7,030	1952	3.18	" "
72	6,010	2338	2.72	" "
73	5,350	1720	7.64	" "
74	6,770	1705	6.70	" "
75	8,850	1640	2.66	" "
76	8,120	1858	4.86	" "
77	5,650	1667	6.03	" "
78	6,300	1396	5.78	" "
79	7,430	1977	6.32	" "
80	6,500	1083	6.39	" "
81	8,375	1483	4.47	" "
82	6,230	1868	5.77	" "
83	8,120	1538	6.52	" "
84	8,880	1453	5.13	" "
85	4,690	1058	18.28	Devonian shale
86	4,880	788	19.56	" "
87	5,030	1027	18.67	" "
88	3,985	1046	19.57	" "
89	4,120	1063	20.83	" "
90	4,375	970	17.65	" "
91	4,570	992	17.05	" "
92	5,030	1000	19.13	" "
93	4,820	947	19.97	" "
94	4,365	1052	19.80	" "
95	4,630	1161	20.22	" "
96	3,315	1103	17.94	" "
97	3,550	1137	17.08	" "
98	3,715	935	19.98	" "
99	4,045	893	19.84	" "
100	4,240	833	21.00	" "
101	3,885	908	20.03	" "
102	4,630	925	20.57	" "
103	3,480	995	20.68	" "
104	3,880	1159	20.85	" "
105	3,500	1143	20.76	" "
106	4,625	893	16.89	" "
107	3,880	938	18.94	" "
108	3,770	808	20.97	" "
109	3,210	818	20.18	" "
110	3,000	1044	19.09	" "
111	3,770	965	19.41	" "
112	3,970	871	20.43	" "
113	5,020	1008	14.53	" "
114	4,820	900	15.38	" "
115	7,050	1105	15.44	" "
116	6,150	1015	15.22	" "

TABLE I (*concluded*)

Serial No.	Compression Strength (lb./sq. in.)	Modulus of rupture (lb./sq. in.)	Absorption by weight (%)	Remarks
117	6,350	1050	16.30	Devonian shale
118	5,370	918	16.22	" "
119	4,570	1098	15.82	" "
120	3,770	1048	4.98	" "
121	4,175	733	16.18	" "
122	4,580	1096	15.90	" "
123	3,120	958	14.88	" "
124	4,670	982	15.38	" "
125	2,325	1360	9.39	" "
126	4,320	1322	3.92	" "
127	5,550	1368	7.77	" "
128	5,250	1125	16.26	" "
129	4,150	970	18.72	" "
130	3,440	964	18.25	" "
131	3,780	1460	14.22	" "
132	4,520	1182	14.58	" "
133	4,980	1253	9.52	" "
134	5,220	1242	12.34	" "
135	4,900	1315	9.17	" "
136	5,420	1488	14.12	" "
137	4,390	1342	9.22	" "
138	4,820	1525	9.69	" "
139	3,980	1388	9.13	" "
140	4,940	1028	12.19	" "
141	5,230	1271	12.08	" "
142	4,485	1266	13.97	" "
143	3,890	878	16.76	Maquoketa shale
144	3,408	863	16.80	" "
145	7,380	1534	11.51	" "
146	7,000	1405	11.97	" "
147	6,315	1330	12.97	" "
148	3,460	773	15.69	" "
149		1659	5.99	" "
150	5,265	1104	14.78	" "
151	4,850	1166	15.38	" "
152	6,470	1375	10.02	" "
153	6,680	2100	4.52	" "
154	8,630	1650	9.77	" "
155	3,480	652	15.15	" "
156	10,090	1670	7.98	" "
157	9,680	1630	7.78	" "
158	6,780	1376	9.89	" "
159	8,550	2143	7.07	" "
160		2053	7.34	" "
161	3,940	675	16.02	Loess clay
162	8,780	1393	8.40	" "
163	9,080	1696	9.83	" "
164	6,170	875	15.63	" "
165	9,290	1325	7.10	" "
166	6,400	1072	14.99	" "
167	5,700	1300	11.81	" "
168	10,820	1432	9.20	" "
169				Lost results in test
170	5,850	791	15.55	Loess clay
171	8,810	1800	9.60	" "
172	6,840	1046	13.77	" "
173	7,480	1128	13.04	" "
174	4,650	828	15.25	" "
175	4,250	742	15.99	" "

soaked over night 16 to 18 hours, boiled in water 3 hours, and cooled over night in the water 16 to 18 hours. Readings were taken on balance to 0.1 gram.

The half-brick from transverse tests were tested throughout "edgewise" for the reason that tests "flatwise" give excess strengths without well-defined failures as shown by the tests later described, this also maintaining the desired ratio of 2:1 for height to width. The bearing surfaces were ground smooth on a horizontally-mounted cast-iron disk or "rubbing bed" 30 inches in diameter, operated at 35 revolutions per minute. The specimens were tried with a straight edge and re-ground where desirable. It was the purpose in this grinding to approximate the ideal hydraulic bearing of Mont Schuyler[31] which gives solely normal pressures on specimens but which are difficult to construct so as to resist the high pressures involved. To secure sensitive hemispherical bearings in applying loads, it was found desirable to wipe and re-oil bearings for each test, so that they could be spun about the axis, the concentration of the load at the outer periphery of the brick being one of the causes of the wide variations in data it was desired to avoid. While most of the bricks could be tested on the 60,000-pound Olsen machine, it was necessary to use a 100,000-pound Riehlé and 200,000-pound Olsen machine in obtaining the strengths for specimens of low absorptions. These were found as before, under four calibrations each, to be accurate well within 1% of applied weights. As in the case of the bending tests specimens were measured to 0.01 inch.

VII. Deduction of Law for Strengths of Silicates

The factor, c, in the formula $p = c \frac{S}{A + A_0}$ may be taken, among its other uses, to give the ratio of the modulus of rupture to the compression strength of a brick. It will be found by trial and inspection of Fig. 1 and the others submitted later that the order of magnitude for this factor is that of Portland cement concrete, ranging from $1/4$ to $1/6$, this being conditioned to a large extent by testing technique. The more appropriate figure of $1/6$ has been adopted for the purposes of later discussion and collation of data. The positions of the curves with the values $1/4$ and $1/5$ are shown on Fig. 1 for reference purposes.

The process of curve fitting is one largely of individual method usually requiring innumerable steps and artifices which need not be considered in great detail.[32] Only the salient features will be considered in the de-

[31] See paper, *Proc. A.S.T.M.*, Vol. XIII, Pt. II, Tech. Papers.

[32] This explanation is intended to be neither rigorous nor academic, but a description of the algorithm of the theory of least squares from a visualistic standpoint. See W. Chauvenet, Spherical and Practical Astronomy, Appendix, pp. 469 *et seq.*, and Marks, Mechanical Engineers' Handbook, 1st ed., pp. 63–119, discussion by Huntington, for the references actually used.

scriptions following. The plot of Fig. 1 indicates that a curve having the general shape of a hyperbola is required which will take a mid course through the data, and according to the plan here announced, will represent fairly well the historical data to be discussed. Assuming the existence of the desired strength function of absorption A, the vertical or normal distance from the plot of the curve defining the function to a particular datum is the residual or approximate "error," v. Treating the curve $p = f(A)$ in the light of a mechanical fulcrum and v as a force, the arm of the force v is also v, and the moment of the force is vv. Extending the reasoning adopted in the case of the direct observation of a single unknown, in brief seeking an appropriate mean, the summation of the moments $vv = v^2$ for any regional group of data comprising the curve should vanish consistently, $\sum vv = 0$ to maintain a balancing of data; also there should be momental equilibrium for the curve as a whole. In general, it is impossible to draw a smooth curve through the centroids of the various point sets of data composing the total aggregation of data, the actual curve found being more or less serrated as a result of the functional incompatibilities arising. The method of least squares makes it a minimum, $\sum vv$ as small as practicable. The analytical method of rectifying the provisional equation by appropriate introduction of suitable functions and using Gauss' method of substitutions in general gives equations too complex for kiln foremen and engineers whose equations should usually be susceptible of mental calculation: In the case of groups of data, as in the present case, the work is so involved as to become prohibitive. To maintain the proper "balance" one must resort to many trials, using tentative formula equipped with

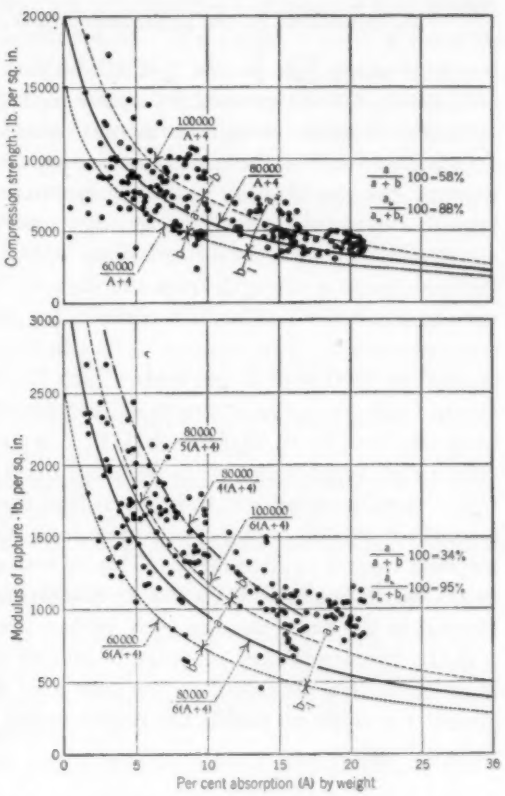

FIG. 1.—Strengths of brick from Iowa (by author).

suitable parameters, which are found by trial or solutions so as to make the final curve fit the data. Numerous trial expressions were used before the resort to the Boyle-Mariotte law already described. The extent to which it was possible to satisfy the criteria of least squares is to be judged in the sequel.

The equation for the strength, $p = f(A)$, finally selected, namely, $p = \frac{80{,}000}{A + 4}$ as announced in the preliminary note, must fulfil certain conditions besides making $\sum vv = \text{min}$. It will be seen that the range adopted for S of 60,000 to 100,000 pounds per square inch as shown in Fig. 1, with a mean of 80,000, is simple enough for mental calculations, as is also the parameter 4 taking account of the insensible pore space per cent. Taking glass as a limiting case for $A = 0$, is the equation consistent at the limit? Will it take in the glasses, obsidians, granite, and the hardest pavers where the absorption is usually small? Taking 20,000 pounds per square inch as a fair compression strength from the data of Trautwine[33] and from Winkelman and Schott[33] the formula satisfies for glass and as shown later for the other materials. The value of $^1/_6$ for c in the case of glass also fits the range of 3000 to 4000 pounds per square inch for the modulus of rupture.[33] In exceptional cases the strength in compression for glass[34] and a paving brick may run up to 40,000 or 50,000. In such cases it will be necessary to take a still lower value of A_0 (about 3 or 2), A, the absorption still being zero. Another condition to insure is that the rectangle $p\,(A + 4)$ is always a constant, 80,000 pounds per square inch, through the entire range of absorption from 0 to 25 or 30%. This, of course, is a reason for the selection of the Boyle-Mariotte type of law; 80,000 and 4% are mutually reconcileable within the finite domain, but within the asymptotic domain when A is in the vicinity of zero, A_0 must be chosen to fit the limiting value for the glass or natural eutectoid as the case may arise. For other than special glasses the equation fulfills the requirements of practice as the subsequent data will attest.

VIII. Consideration of the Probable Errors

The probable error of a single datum is defined as such an "error" that it is an even chance that the calculated value is less or greater than the true value according to the theory. The formula of the mathematician C. A. F. Peters[35] will be used in preference to the more logical one of Bessel

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[33] Marks, Mechanical Engineers' Handbook, 1st ed., p. 632.

[34] Marks, *op. cit.*, 3rd ed., p. 747. Kent's Mechanical Engineers' Handbook, 8th ed., p. 349 quotes a St. Louis paver at 38,446 lb. per sq. in. in compression, at Watertown Arsenal.

[35] Originally given in *Astronomische Nachrichten*, Vol. XLIV, p. 32.

because it gives essentially the same results and is easier to visualize as an average deviation from the mean...

$$r = 0.85 \frac{\Sigma v}{\sqrt{n(n-1)}}$$

the sum of the residuals, v, being used instead of the sum of their squares, $\sum vv$, n standing for the number of observations for a chosen set having the mean value A, and the mean resistance, p. If n varies from 2 to infinity the probable error, r, varies from 0.6 to 0.85 of the average of the local residuals. With so few as five data, r is 0.8 of this average. The probable error being merely a statistical convention in any event, it may accordingly be taken either as the average of a local set of data whose centroid is near the point p, A on the curve, or more exactly $^8/_{10}$ of this amount. Using the latter coefficient, and considering an unfavorable case, the data between the ordinates, through $A = 8$ and $A = 10$, with an average of $A = 9$, regardless of whether the points are above or below the curve $p = \frac{80{,}000}{A+4}$, there results $0.8 \frac{\sum v}{n} = 0.8(6150) = 1760$ or 1760/6150 of 100 equals 28.6%. This being merely a trial value and somewhat in excess, the number of the aggregate data being rather small, may be "rounded-off" to about 25%, representing the plus or minus variation in fixing limits, subject to the final statistical check to be given in the discussion of the silicate data. Assuming provisionally that ± 0.25 or $\pm 25\%$ is a reasonable deviation from the mean, $p = \frac{80{,}000}{A+4}$, this is the degree of variation a kiln operator may expect from the formula when he soaks or boils a brick according to the approved manner, in the long run. It will be shown, according to the data of the last half century, that it is better than an even wager that actually it is less than the above amount.

Peters' corresponding formula for the probable error of the mean of several observed data is

$$r_0 = 0.85 \frac{\sum v}{n\sqrt{(n-1)}}$$

where $\sum v$ is the sum of the residuals as before and n is the number. It is found by divison with the preceding formula that $r_0 = \frac{1}{\sqrt{n}} r$. This result may be applied to the case of a few data without great error, these tending to cluster around the mean value (as defined by the law) as in the case of the larger group which may be found by trial, taking every fifth datum, for instance, instead of the total number between two neighboring verticals.

Accordingly, if the aforementioned kiln operator should take a minimum of five brick as recommended by Committee C3 of the A.S.T.M., instead of one, having the same degree of "firing" as defined by color or position in the kiln, the probable error will be $r_0 = \frac{1}{\sqrt{5}} r = \frac{1}{2.2} r$, or about half that for a single brick: for ten brick with the same degree of "firing" it will be about $^1/_3$ as much and so on, the variations being cut down to 12 and 8%, respectively. It will be shown in the discussion of the data that averages covering more than ten brick will fall on the curve $p = \frac{80{,}000}{A + 4}$ or close to it in systematic researches. Now in other branches of engineering, for example in column, concrete, and timber testing,[36] the variation found is often 25 or 50% from the mean. It is to be inferred from the argument of this paper, that the strength of a structural silicate falls well within this amount; indeed, if the ceramist wishes to plot averages of results, from 5 to 50 or 100, as is frequently the practice of scientists and technologists, instead of single datum, the small variations found in other cases will be obtained. This practice with or without "weighting" of the separate plotted data is considered legitimate according to statistical ethics, and has been followed to some extent in the researches to be discussed. Since, however, it "camouflages" the actual degree of precision, it has not been used in the preliminary research on Iowa brick considered in getting the law, $p = \frac{80{,}000}{A + 4}(1 \pm 0.25)$. Moreover, no results were rejected because they were far from the mean expected.

Some of the large deviations from the law found may easily be conjectured in advance of the discussion:

(1) Taking $p = \frac{80{,}000}{A + 4}(1 \pm 0.25)$ as the correct law, the results greater than $\frac{100{,}000}{A + 4}$ are largely the results of "flatwise" tests in the case of brick. A three- or four-foot plank laid flat in a testing machine will support 10 million or more pounds as a result of the tangential frictions from testing machine platens, far more than the strength of the tracheid fibers. A brick has excess strength for similar reasons, the lateral reinforcement.

(2) The data at the left of the figures, in deficiency, appear to be due to the weakening effect of surface and internal cracks or laminations on the very brittle materials with low absorptions. Whole brick are better tested specimens. Brick with star-shaped holes along the central lines also are believed to lower the resistance as a result of re-entrant angles. There is

[36] American Inst. of Steel Construction, Steel Construction, 1st ed., p. 176. This is the amount of deviation of well-known formulas for bridge columns of 100 to 120 $1/r$. Also for concrete cylinders, Johnson's Materials of Construction, 6th ed., p. 816. Also for timber, *ibid.*, p. 213, singly and with extensive averaging of results.

little difference in plots of the brick with holes and those without holes along the central lines of faces. No effects of weakening could be found from the rough surfaces in certain cases: if they exist they are within the probable errors calculated.

(3) Some of the low values for the moduli of rupture for brick may be due to the fact of breaking upon the curved block. Although this plan was carried out in the preliminary research on Iowa brick as a concession to recommended practice the opinion is expressed that mounting the specimen on a plane surface without opportunities for rotations about axes of brick will aid in giving higher breaking stresses.

IX. General Discussion of the Historical Data

Some "weighting" should be given the data of the past fifty years if they are placed on a common basis. Certain authorities in the past have used thick "cappings" of plaster of Paris, others have ground specimens, and others have used layers of heavy paper; some tests have been made "edgewise," others "flatwise"; certain investigators have averaged several results to give a single datum on a plot, others plot single observations, and so on. On account of the promiscuous character of the observed data whatever weighting and compensation is done must largely be by judgment, "balancing" the untoward features to give suitable means. This has been carried out in getting the curves.

Since the historical data were not obtained according to a common preconceived plan of procedure, it may seem wise to have a varying scale of deviations, just as Sir Isaac Newton in building a kennel had one exit for the large canines, another for the pups, according to the apocryphal annals. In marksmanship, however, one does not have a graduated target, small for experts and larger ones for those less proficient. A single mark suffices. Proficiency is measured by the number of hits within the target or "bulls eye." In the present case, the "mark" is the zone of data defined by the variable $\pm 0.25 \frac{80{,}000}{A + 4}$, comparable to one of the "scrapped" cruisers used by modern navies. Let a be the number of data falling within the zone and b the number outside, above, or below. The fraction $\frac{a}{a + b}$ will be arbitrarily selected as a measure. The fraction should be $1/2$ for a properly chosen probable error in the case of a single datum, which means half are within the belt and half of the total number without. Since a conservative value of $1/6$ the compression strength has been chosen for the moduli of rupture there will also be another ratio taken: let a_u be the data above the lower boundary of the zone and b_1, those falling below this boundary. Since investigators wish to know whether their predictions are on the "safe side," the ratio $\frac{a_u}{a_u + b_1}$ will afford a measure of this. The ratio $\frac{a}{a + b}$

TABLE II
SUMMARY OF EFFICIENCIES

Description	Figure	Authority	Ratio Comp.	$\frac{a}{a+b}100$ Bend.	$\frac{a_u}{a_u+b_1}100$ Comp.	Bend.
Brick	1	Author	58	34	88	95
Building stones	2	Merrill	52		84	
Paving brick	3	Johnson	75	77	81	95
Paving brick	3	Ill. Geol. Surv.		63.5		73
Brick	4	Louisiana Pur. Ex.	40		80	
Brick	5	Comm. C3 A.S.T.M.	58	43	87	85
Brick	6	Comm. C3 A.S.T.M.	54		75	
Brick						
Fire			38		58	
Sand lime			64		87	
	7	Louisiana Pur. Ex.				
Brick	8	Va. Polytech. Inst.	40	36	50	76
Brick	9	Bur. of Stand.				
		Univ. of Washington	48	53	79	94
Brick						
Clay and sand-lime	10	Bur. of Stand.	71	29	71	100
Hollow tile	11	Bur. of Stand.				
		Comm. C3 A.S.T.M.				
		Underwr. Lab.	60	78	74	88
Drain tile	12	Iowa State Coll.		64		94
Sewer pipe	13	Iowa State Coll.		68		92
				75		95
				54		62
				80		83
		Averages	55	58	76	87

is 58 and 34%, respectively, in the case of the compression strength and modulus of rupture of the Iowa brick, $\frac{a_u}{a_u + b_1}$ being 88 and 95% for the corresponding cases. The ratios are given in Table II in each instance for the following materials affording the means of comparison.

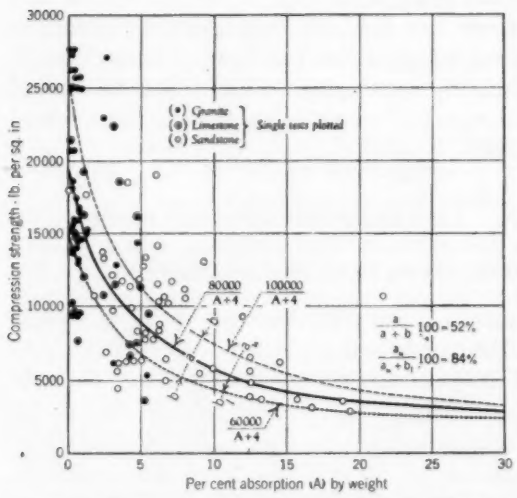

FIG. 2.—Strengths of building stones from Merrill's Stones for Building and Decoration, tests by Q. A. Gillmore and others, pp. 498–507.

(1) Tests of Building Stones The data from Merrill's work[24] (*loc. cit.*) covering the tests of stones by General Gillmore and other authorities have been plotted in Fig. 2. The granites and other pre-Cambrian rocks are properly silicates, the limestones, marbles, tuffs, and sandstones being con-

sidered limiting aspects for the system calcium–aluminum–silica, since they also follow the modified Boyle-Mariotte law proposed in the same manner as the igneous rocks. In this case for the compression strengths, the only ones given by Merrill, 58 data fall within the zone and 53 outside so that $\frac{a}{a+b}$ 100 is 52, better than an even wager that building stone will follow the proposed law. On the other hand, the ratio giving the probability of the excess above the minimum is 84.

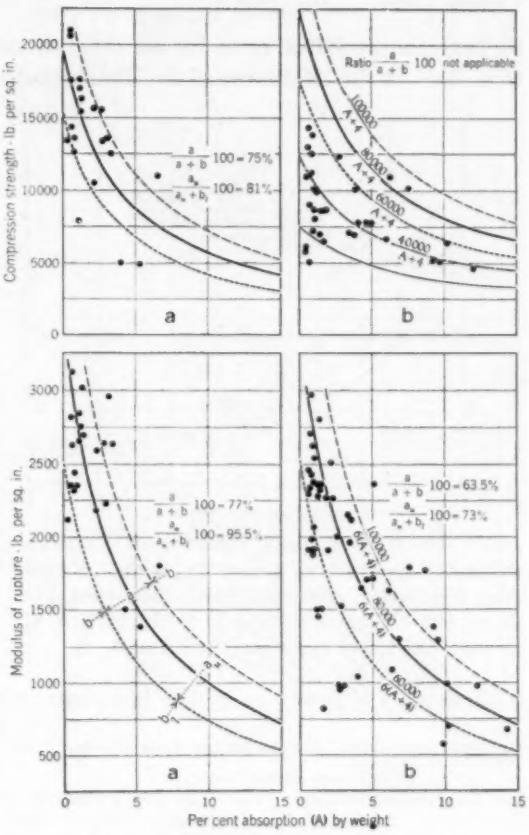
Compression strength - lb. per sq. in.
Ratio $\frac{a}{a+b}$ 100 not applicable
$\frac{a}{a+b}$ 100 = 75%
$\frac{a_o}{a_o+b_i}$ 100 = 81%
$\frac{a}{a+b}$ 100 = 63.5%
$\frac{a_o}{a_o+b_i}$ 100 = 73%
Modulus of rupture - lb. per sq. in.
$\frac{a}{a+b}$ 100 = 77%
$\frac{a_o}{a_o+b_i}$ 100 = 95.5%
Per cent absorption (A) by weight
a
b

FIG. 3.—Strengths of paving brick. (*a*) Brick ground smooth, bedded in tarboard, tested "edgewise"; (*b*) brick bedded flatwise in several layers of heavy building paper. Johnson's Materials, 4th ed., p. 661. Illinois State Geol. Surv., *Bull.*, No. 9.

Transverse test results are not available from Merrill's tables. The ratio 1/6 for the modulus of rupture is fairly concordant in the case of Buckley's results as quoted by Withey and Aston. The value is lower in the case of Bauschinger's data by the same authorities.[37] Building stones, however, are greatly influenced by the presence of quarry water or other moisture and temperature changes. While engineers apply the Bernouilli-Euler beam hypothesis indiscriminately to almost any "beam" from a "T-square blade" to a gear tooth, it should be remembered in the light of Karl Pearson's research[30] that the theory is only approximate, applying only to long flexible beams strictly and not to the short ones. Consequently, if building stones are tested transversely

[37] Johnson's Materials of Construction, 7th ed., pp. 255–58.

and the proposed formula is applied the specimens must be chosen of standard brick sizes if the results are on a parity.

(2) Tests of Paving Brick

Dean Johnson's data on pavers,[25] when plotted give the ratios $\frac{a}{a+b}\ 100 = 75$ and $\frac{a_u}{a_u+b_1}\ 100 = 81$, so that the probable error for an observation is less than the $\pm$ 25% (Fig. 3). In the 1908 series of the Illinois State Geological Survey[38] plotted alongside Johnson's data and covering many of the best American pavers, the specimens were bedded in several thicknesses of building paper so that they cannot be compared in fairness with the higher figures of Johnson's unknown products. Since, however, both series develop the full-zone strengths for the moduli of rupture data it is only natural to believe they would show the same parallelism with respect to the compression strengths if there were a parity as to the bedments, whereas actually the formula representing the Illinois series reduces to $p = \frac{40{,}000}{A+4}\ (1 \pm 0.25)$, just half the realizable values. There is every reason to believe that thin bedments or ground surfaces would develop the full strength, $p = \frac{80{,}000}{A+4}\ (1 \pm 0.25)$, as amply attested by Johnson's data in the other case.

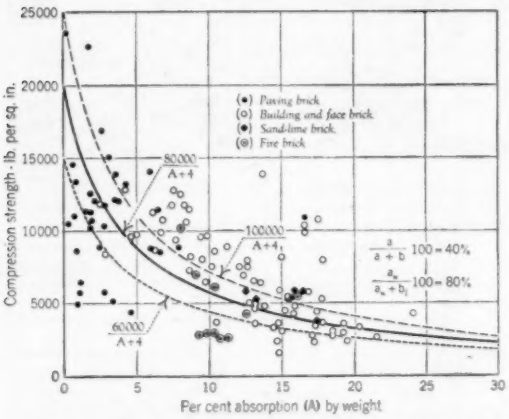

FIG. 4.—Tests of brick collected at Louisiana Purchase Exposition, St. Louis, Mo., 59th U. S. Congress, 2nd Session, 1906–1907, House Document, Vol. 46, pp. 603–16 (report of Major F. E. Hobbs, U. S. A., (in part) to Chief of Ordnance, U. S. Army).

(3) The Louisiana-Purchase Exposition Brick[39]

This series includes pavers, fire brick, and sand-lime and building brick from sixteen states and Hungary, the plot of Fig. 4 covering those for which the absorptions were given, but without the

[38] Illinois State Geol. Surv., *Bull.*, No. 9.

[39] House of Representatives, Doc. No. 46, "Tests of Metals, No. 26," 59th Congress, 2nd Session, 1906–1907, being partial report of Major F. E. Hobbs, U. S. A., to Chief of Ordnance.

modulus of rupture data. The sand-lime brick and fire brick are also plotted later in Fig. 7. The ratios $\frac{a}{a+b}100$ and $\frac{a_u}{a_u+b_1}100$ are 40 and 80%, respectively. The data in excess of the upper zone boundary, $p=\frac{100{,}000}{A+4}$, are attributed largely to the flatwise tests.

(4) Tests of Brick by Committee C3, A.S.T.M.[40] Much weight is due this series sponsored by Committee C3, A.S.T.M., owing to the care in which the project was carried and its national scope in covering thirteen states under a well-organized plan of research. This series includes the various kinds of building brick with some sand-lime brick. The plotted data of Fig. 5 in each case represents an average of five brick, cognizance of which should be taken in comparing with the preceding, in which a datum represents one test only.

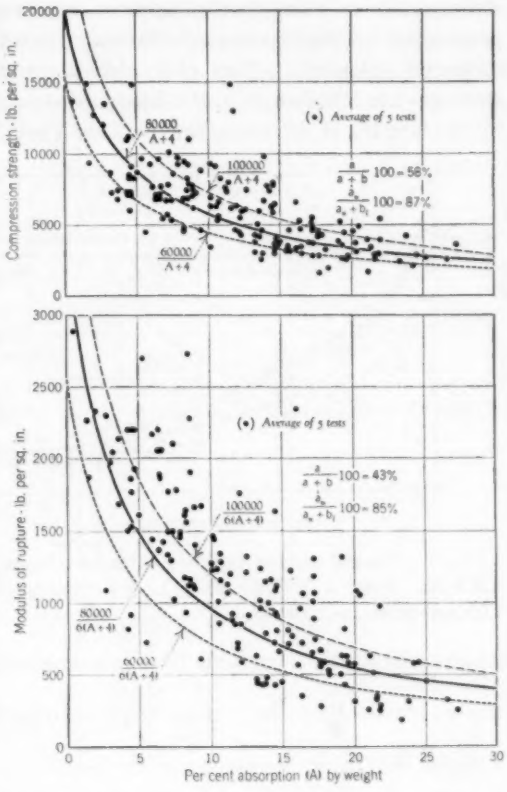

FIG. 5.—Strengths of brick: Comm. C3, A.S.T.M.[41]

The ratio $\frac{a}{a+b}100$ is 58% for compressions and 43% for transverse tests, the corresponding values of $\frac{a_u}{a_u+b_1}100$ being 87 and 85.

(5) Special Tests of Brick by Committee C3, A.S.T.M.[41] By carrying out the recommendation of Committee C3, A.S.T.M., with which the present paper is in agreement, the types of failures which cause a scattering on the plots may be largely

[40] *Proc. A.S.T.M.*, **25** [1], 152–60 (1925).
[41] *Ibid.*, pp. 156, 157, 162 (1925).

eliminated. This is illustrated in a plot of their special data shown in Fig. 6, where the flatwise tests are plotted with those tested edgewise, the strengths being in the ratio 1.15 to 1, respectively.

The tests on Iowa brick recorded in Table I, while possessing lower strengths from being made edgewise, are compensated in about the same proportion by the increase of efficiency from the ground surfaces and other measures adopted. The plot also contains the Bureau of Standards averages on Pittsburgh and Chicago districts, as well as those submitted by the late Ira H. Woolson for the New York District, three of which fall on the curve, $p = \frac{80{,}000}{A + 4}$, and the fourth within the zone at the lower boundary, already referred to earlier in this paper.

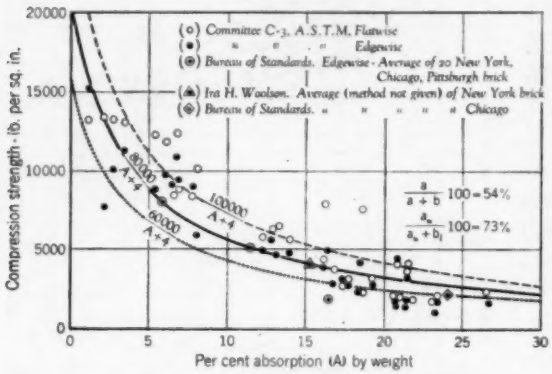
(o) Committee C-3, A.S.T.M. Flatwise
(•) " " " " Edgewise
(⊕) Bureau of Standards. Edgewise - Average of 20 New York, Chicago, Pittsburgh brick
(▲) Ira H. Woolson. Average (method not given) of New York brick
(⊕) Bureau of Standards. " " " " " Chicago
Compression strength - lb. per sq. in.
Per cent absorption (A) by weight
80000 A+4
100000 A+4
60000 A+4
a/(a+b) 100 = 54%
a_u/(a_u+b_1) 100 = 73%

FIG. 6.—Special tests of building brick by Comm. C3, A.S.T.M., *Proc. A.S.T.M.*, **15** [1], 162 (1915). Table VII, and others, *loc. cit.*, p. 157.

(6) Fire Brick and Sand-Lime Brick It was hardly expected that these would follow the same laws as the other silicate products. The evidence from the tests abstracted from the Louisiana Purchase Exposition plot of Fig. 4 is that they will at least follow the general type of hyperbolic law, $p = \frac{S}{A + A_0} \pm e$. A slight shifting in the parameters A_0 and S may be required but the information presented shows no need of such an adjustment, as is also true of the later data reviewed. The ratios $\frac{a}{a + b}\,100$ for fire brick and sand-lime brick as shown on Fig. 7 are 38 and 64%, respectively, the corresponding values of $\frac{a_u}{a_u + b_1}$ being 57.8 and 86.5.

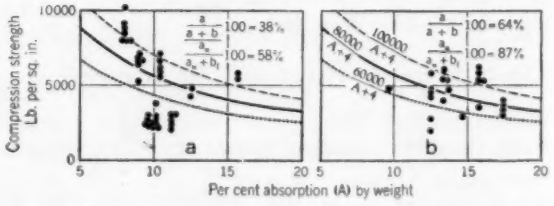

FIG. 7.—Tests of sand-lime and fire brick (abstracted from House of Rep. Doc., Vol. 46, pp. 603–16. (*a*) Test of fire brick; (*b*) test of sand-lime brick.

(7) Virginia Polytechnic Institute Tests of Brick[42] The tests conducted by Whittemore and Dear, of which the data has been plotted in Fig. 8, represent the latest results carried out in accordance with the provisions of Committee C3 A.S.T.M. These authorities give the averages of five tests each together with the maxima and minima, which are indicated on the figure. There is some scattering of the data which the evidence from the other series discussed indicates is not normal. There is also some condensation below the recommended zone which has been taken into account in fixing the law $p = \frac{80{,}000}{A+4}(1 \pm 0.25)$. The ratios $\frac{a}{a+b}100$ are 40 and 36 for the compression and transverse tests with corresponding values for $\frac{a_u}{a_u+b_1}100$ of 50 and 76. There is no evidence presented in the research to warrant the opinion that Virginia brick have lower strengths than those from Alabama or Utah other than the test results. If Orton's hypothesis is true generally, that absorption is a measure of the degree of vitrification, one of the fundamental working hypotheses of the present paper, brick from ancient Babylon or Nineveh should show strengths conformable to the law $p = \frac{80{,}000}{A+4}$ (1 ± 0.25). This is no greater tax on the credulity than having the pre-Cambrian rocks fabricated in the "kilns" of nature following this law as has been

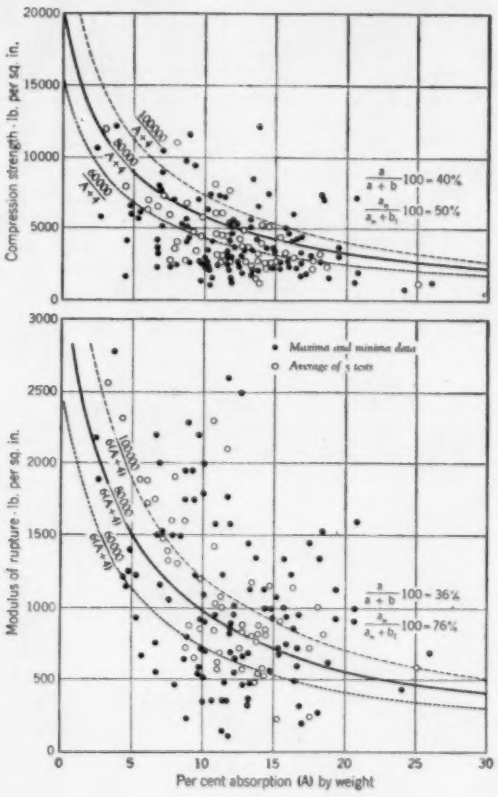
Compression strength - lb. per sq. in.
Modulus of rupture - lb. per sq. in.
Per cent absorption (A) by weight
Maxima and minima data
Average of 5 tests
100000/A+4
80000/A+4
60000/A+4
a/(a+b) 100 = 40%
a_u/(a_u+b_1) 100 = 50%
a/(a+b) 100 = 36¼
a_u/(a_u+b_1) 100 = 76¼

FIG. 8.—Strengths of brick (Virginia Polytechnic Inst.).[42]

[42] Whittemore and Dear, Virginia Polytechnic Inst., Expt. Sta., *Bull.*, No. 6.

clearly established from the plot of Merrill's results (Fig. 2) with which Buckley's results appear to be consonant.[37]

(8) Bureau of Standards and Washington University Tests of Brick[43]

The plot of Fig. 9 shows a comparison between eastern and western extremes. The Bureau of Standards tests in compression conducted by Bragg, for New York, Pittsburgh, Chicago, and New Orleans-Birmingham districts, according to the plans of Orton, and those of the University of Washington, "obtained from Seattle and vicinity" under the direction of Fuller, shows a ratio $\frac{a}{a+b}100$ for the entire group to be 48, and for bending, 53, the values of $\frac{a_u}{a_u+b_1}100$ to correspond, being 79 and 94. The coefficient, c, giving the relative values of the modulus of rupture, is nearer $^1/_5$ than the more conservative value chosen of $^1/_6$. These results confirm the opinion expressed earlier in the paper that the moduli of rupture of many American brick heretofore recorded are in many cases subnormal, and can be raised by a more efficient mechanical technique in testing, as shown by other of the researches than those just mentioned.

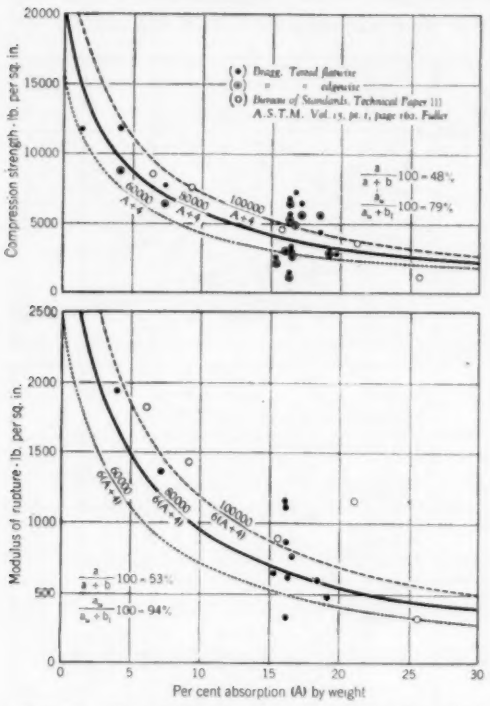
Compression strength - lb. per sq. in.
Modulus of rupture - lb. per sq. in.
Per cent absorption (A) by weight
Bragg. Tensil flexure
" " edgewise
Bureau of Standards. Technical Paper 111
A.S.T.M. Vol. 15, pt. 1, page 162. Fuller
100 = 48%
100 = 79%
100 = 53%
100 = 94%

FIG. 9.—Strengths of brick, Bur. Stand., *Tech. Paper*, No. 111, by J. G. Bragg and Univ. of Washington, by A. H. Fuller, *Proc. A.S.T.M.*, **15** [1], 162 (1915).

(9) More Recent Bureau of Standards Tests

The later tests of the Bureau of Standards by S. H. Ingberg attest further to the truth of the preceding remark, and give further evidence about sand-lime brick following the proposed law; the steamed and kiln-fired products go about the same in compression and flexure.

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[43] Bur. Stand., *Tech. Paper*, No. 111, Tables, and *Proc. A.S.T.M.*, **15** [1], 162 (1915).

As before, the edgewise results are a little below the flatwise according to the previous reported ratio. Ingberg's compression tests yield an efficiency of 71 for $\frac{a}{a+b}$ 100 and 71 for $\frac{a_u}{a_u+b_1}$. While $\frac{a}{a+b}$ 100 = 28.5 is a little low according to the least square algorithm adopted, there being no data below the lower "frontier," the value $\frac{a_u}{a_u+b_1}$ 100 is 100% as a result of the high value of the coefficient attained for c in the case of the transverse tests.

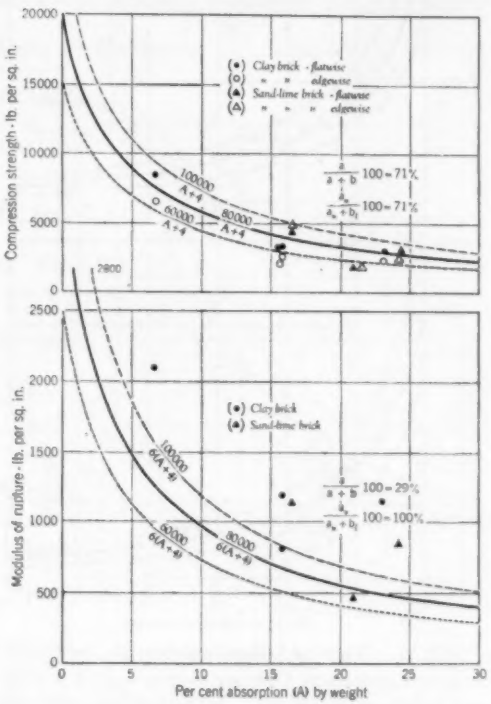
Compression strength - lb. per sq. in.
(•) Clay brick - flatwise
(○) " " edgewise
(▲) Sand-lime brick - flatwise
(△) " " edgewise
100000 / A+4
80000 / A+4
60000 / A+4
2800
a / a+b 100 = 71%
a_u / a_u+b_1 100 = 71%
Modulus of rupture - lb. per sq. in.
(•) Clay brick
(▲) Sand-lime brick
100000 / 6(A+4)
80000 / 6(A+4)
60000 / 6(A+4)
a / a+b 100 = 29%
a_u / a_u+b_1 100 = 100%
Per cent absorption (A) by weight

FIG. 10.—Strengths of brick, Bureau of Standards, by S. H. Ingberg, *Proc. A.S.T.M.*, **24** [2], 911 (1924).

(10) Tests of Hollow Building Tile by Bureau of Standards, Comm. C10, A.S.T.M. and Underwriters' Laboratory The percentages for data within the belts are 68 and 81, respectively, as indicated on Fig. 10, the tests being conducted endwise to give the highest strengths for these commodities. Data for flatwise and edgewise tests follow the modified Boyle-Mariotte law with reduced values for c, the orders being about $^6/_{10}$ and $^3/_4$, as compared with the compression strengths. If the data represented "hit" on a cruiser instead of a mere plot the effect would obviously be disastrous. That a high set of values has been obtained for both ratios is not alone due to mechanical technique in this case, but also to the fact that the volume of the end "capping" in each case is small in relation to the volume of the tile as compared with a brick. If the tile is ground on a surface grinder or rubbing-bed the ratio of the aforesaid volume is zero and tile provided with such bearing surfaces, in the author's experience, will fail under loads about 50% higher than the capped specimens, thus helping to fulfill Dr. Abram Joffé's[28] ideal of obtaining 100% lattice efficiency. The ratios for the percentages above the lower boundaries are nearly 100% in both compression and bending tests.

(11) Tests of Drain Tile and Sewer Pipe

The theory[44] of behaviors for drain tile and sewer pipe is essentially identical. In general, on a filament or bar of matter under strain at a transverse section there is thrust, shear, a bending couple, and a twisting couple. Since there are three orthogonal planes of symmetry, neglecting the presence of the "bell" on the sewer pipe, for the standard "set-up" in the testing machine, and no lateral restraint at the "springs" of rings, the thrusts at the crowns and the shears and the twists at the crowns (upper and lower) and the springs vanish, the stress couple being finite at these points and throughout the central line s of the ring. The angle between the tangents to the elastic line at the crown and spring remains the same before and after strain, namely $\pi/2 = 90°$ under equal and opposite forces, W pounds per lineal foot along the vertical diameter. Hence the moment area by the late C. E. Greene's[44] theory is zero, or analytically, $\int_o^{\frac{\pi}{2}R} M_s\, ds = 0$, where M_s is the moment at distance s measured from origin at the spring and ds is an element of the distance. The value of this moment expressed as a function of the moment at the spring M_0, the radius of the central line of ring R, and the angle $\Theta = s/R$, is $M_s = M_0 + \frac{W}{2}(R - R\cos\Theta)$. Substituting, taking $\frac{ds}{R} = d\Theta$, and integrating from the origin to 90° or 0 to $\pi/2$, the moment at the origin

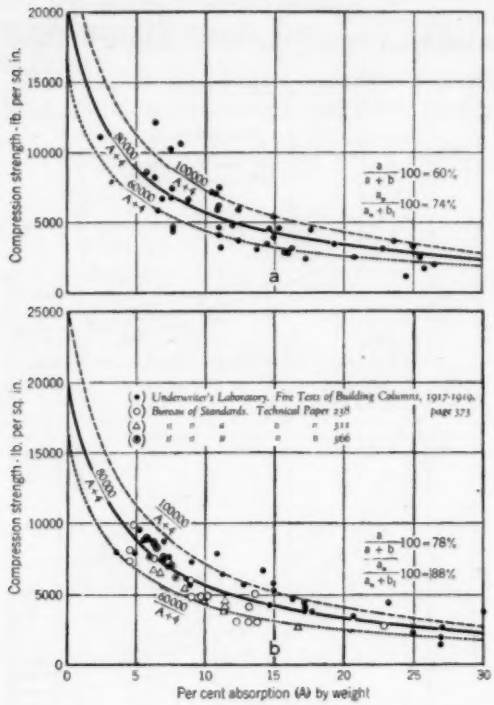

FIG. 11.—Tests of hollow building tile, by Underwriter's Laboratory, Chicago, Comm. C10, A.S.T.M. and Bureau of Standards: (*a*) tested "on end," net section area; tests by Comm. C10, A.S.T.M., *Proc. A.S.T.M.*, **24** [1], 412 (1924); (*b*) tested "on end," net section area.

[44] Discussed in Greene's Structural Mechanics, 3rd ed., p. 219.

is found to be $0.182\,\frac{WR}{12}$ per inch of pipe length, and the governing value at the crowns (upper and lower) where the loads W are applied is $0.318\,\frac{WR}{12}$, from which by substitution in M_s the general value may be found. The formula for the breaking stress is the ordinary Bernouilli-Euler expression used for the moduli of rupture of the brick, $\frac{Mc}{I}$, where M is $0.318\text{-}\frac{WR}{12}$ as previously given and c is half the pipe thickness $\frac{t}{2}$, the moment of inertia I being $\frac{1 \times t^3}{12}$. Hence the formula for the breaking stress at the crown where the fractures first occur is $f = \frac{Mc}{I} = \frac{6M}{t^2}$. The results obtained for these moduli of rupture by different authorities at the Engineering Experiment Station of Iowa State College[45] under different methods of loading are shown in Figs. 12 and 13. The condensation of the data within the zone $p = \frac{80{,}000}{6(A+4)}\,(1 \pm 0.25)$ insures high values for the ratios $\frac{a}{a+b}(100)$ and $\frac{a_u}{a_u + b_1}\,(100)$ in all cases.

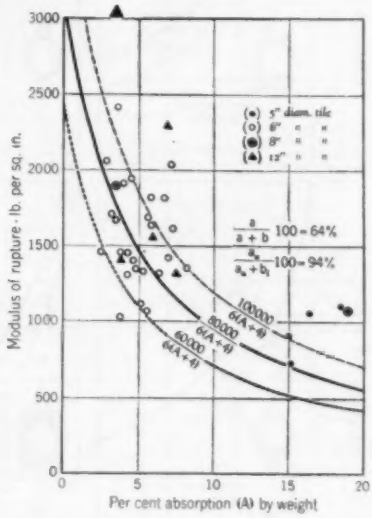

FIG. 12.—Strengths of clay drain tile, Iowa State College, Eng. Expt. Station, *Bull.*, No. 31, p. 130.

Pipes cannot be assumed on a volume parity with brick; the thickness in this case is less than for brick and the span length instead of being 7 inches must be regarded either infinitesimal or indeterminate: in the case of drain tile, moreover, the effects of lamination are more pronounced than in the case of brick. It is seen nevertheless and notwithstanding these facts that the Boyle-Mariotte type of law is sufficient in predicting behaviors and collating the data. The efficiencies obtained are as high as any of the group.

Salt-glazed pipe have not been included in the above plots on account

[45] See Iowa State College, Eng. Expt. Sta., *Bull.*, No. 31, pp. 31 and 130, and No. 47, pp. 38 to 45, inc. Johnson's Materials of Construction, 7th ed., p. 277, gives methods of loading in detail.

of the lack of parity due to the relatively impervious outer shell of material. If this were ground off, water would penetrate at the same rate as in the other cases and the parity be maintained.

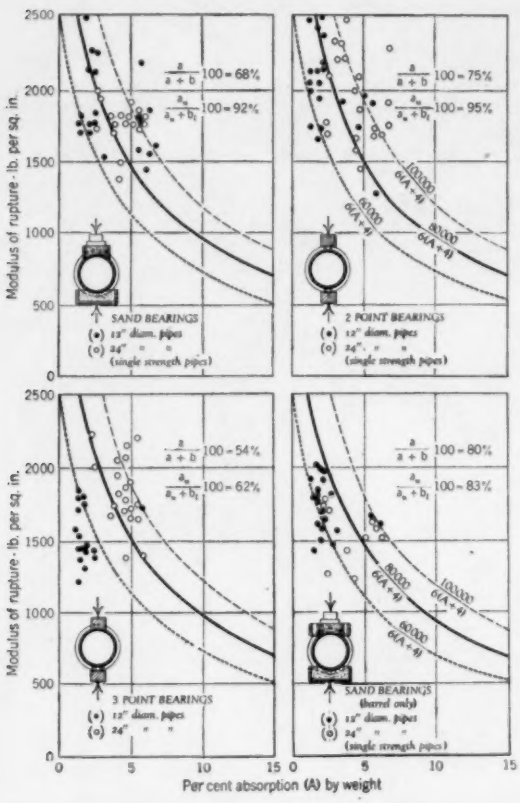

FIG. 13.—Strengths of sewer pipe, Iowa State College, Eng. Expt. Station, *Bull.*, No. 47, pp. 38–45.

Although the coefficient, $c = 1/6$, fits the test results very satisfactorily, the efficiencies for moduli of rupture can be raised for the same reasons as apply to brick and tile by attentions to bedments. Just as the pressures of water and the velocities are higher at a nozzle, and heat and electricity flow off a point most easily, as in the case of a lightning rod, so stress is most intense generally at a "bump" or papilla causing a "pole" or infinity of pressure, so that ground surfaces and plaster bedments, as in the former cases, have the advantage over the untrued two- and three-edge bearings. Since matter is merely an order of energy as are heat, electricity, or light, and treated as an "incompressible fluid" (as instanced in the theory of the displacement potential)[46] follows the same law as the other manifestations, that of Laplace, it should be given the same consideration as any other form of energy. One seeks 100% efficiency in turbines and generators and should do the same in the flow of the entity from higher to lower densities.

(12) National Brick Manufacturers' Association and Bureau of Standards Tests of Brick Piers

It was shown earlier in the paper that Abrams' law for the strength of Portland cement (chemically a particular case of the system

[46] Benjamin Williamson, Introd. Math. Theory Stresses and Strains in Elas. Solids, p. 21.

calcium–silica–alumina) is formally equivalent with the proposed Boyle-Mariotte expression for silicate products if the denominator is developed by Maclaurin's series and the higher order terms rejected. Since the separate components of masonry follow the law $p = c\,\frac{80{,}000}{A+4}$, brick or stone masonry itself should also follow this law by mere superposition of effects. This will be demonstrated in the case of large brick piers.

In 1914, Orton, as Chairman of Research for the National Brick Manufacturers' Association in coöperation with the Bureau of Standards, outlined the program of research on large brick piers. The strength tests, excepting for piers with lime mortars, as executed by J. G. Bragg, Assistant Physicist of the Bureau, are plotted in Fig. 14. In the report of the tests[43] attention is called to the fact that flexural failures predominated, as was demonstrated visually at the time and from the characters of the brick fractures; also from the fact that the mortar could be reënforced by wire meshing. From this cue, taking the relation or flexural factor c at its upper limit $^1/_4$ instead of $^1/_6$, as used heretofore for the other individual cases, since there are in this instance no opportunities for twists and other untoward behaviors, it is found that the law for brick masonry under vertical pressure is $p = \frac{80{,}000}{4(A+4)}(1 \pm {}^1/_4)$, which should also hold for stone masonry in view of Merrill's results in Fig. 2. The tests in the case of the lime mortars follow the law with lower values of c, but Bleininger and Bragg report that such mortars do not carbonate in the case of thick masonry.

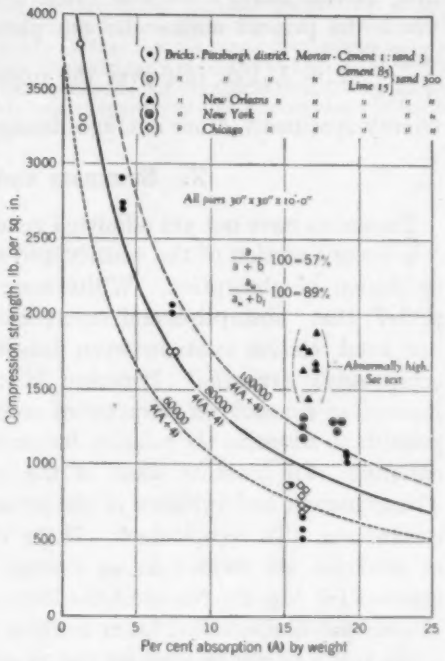

FIG. 14.—Strengths of brick piers: coöperative research by Bur. Stand. and N.B.M.A. Tests by J. G. Bragg, Bur. Stand., *Tech. Paper*, No. 111 (1918). Program of Edward Orton, Jr., Chairman of Tech Comm., N.B.M.A.

The data for the piers of New Orleans brick plotted on Fig. 14 as triangular dots above the upper curve are anomalous, being abnormally high, only one absorption datum being obtained for several compression re-

sults. The results contributed by Gregory and Koch and by E. B. Kay for the New Orleans and Birmingham districts in the report of Committee C3 (footnote 40 and Fig. 5) on the other hand are free from this objection and show a good condensation within the prescribed zone for p up to $\frac{a}{a+b}$ 100 = 80 for the particular range of absorption, 15 to 18, under consideration. Even Bragg's flatwise brick averages (footnote 40 and Fig. 9), which the present author did not plot, fall either within the zone $p = \frac{80{,}000}{A+4}(1 \pm 1/4)$ or just over the upper boundary in the case of sets of twenty specimens, other averages being shown on Fig. 6.

X. Summary and Conclusions

Ceramists have not yet admitted generally that the strength of a silicate is a linear function of the density and an inverse function of the porosity or degree of absorption. Whittemore and Dear remark (footnote 42, p. 347) that "absorption and strength tests cannot be correlated" and that "no fixed relation exists between flatwise transverse strength and flatwise compressive strength." Himansu Mitra,[47] in summing the results of an interesting research on refractories, comes to the conclusion that it is impossible to subsume the relation for strength and absorption by any simple equation. He presents some of the evidence from various authorities. The argument and evidence of the present paper do not substantiate such statements. To recapitulate: If the various structural silicates, natural or artificial, are treated as an average group of the system lime–silica–alumina (+ Mg, Fe, Na, etc.), the Boyle-Mariotte pressure-volume relation at constant temperature, being nothing more than another form of stress-strain relation, can be used for the graph when the stress or strength at the stress limit is expressed either in terms of the density, the volume, the porosity, or absorption, for these are mutually convertible. The same equation applies to rapid and slow compressions because the ratio of the specific heats is nearly unity for solids. The data of the last half century show these facts conclusively. The averages of Table II demonstrate the fact that it is better than a "fifty-fifty" proposition that the probable error for a single datum is less than 25%, better than that holding for steel columns, timber, and concrete construction as far as predictions as to strengths are concerned. It is better than a 75:100 proposition that an error in prediction according to the formula will be on the side of safety, under instead of over. The conclusion is patent: A structural silicate has the strength of granite when it has the absorption or density of granite, as has limestone

[47] "Cold Crushing Strength of Fire Brick," Ohio State Univ., Eng. Expt. Sta., *Bull.*, No. 54, p. 2 (1930).

or sandstone. It is weak as it is porous, excluding "chemical frictions" and special heat treatments.

Acknowledgments Acknowledgments are due the following Iowa firms who donated the brick used in the tests: Capitol Plant of the United Brick and Tile Co., Centerville Brick and Tile Co., Clermont Brick and Tile Co., Des Moines Clay Co., Mason City Brick and Tile Co., Rockford Brick and Tile Co., Sheffield Brick and Tile Co., and the Sioux City Brick and Tile Co.

The author wishes to express his thanks to Paul E. Cox, Head of Ceramic Engineering at Iowa State College, for permitting the use of the Ceramic Laboratory at the College for the preparation of compression test specimens, and to Almon H. Fuller, Head of the Department of Civil Engineering at the College, for the use of the various testing machines used in the research. The author is particularly indebted to Don A. Moulton for conducting negotiations in obtaining test specimens, for superintending the operation of properly grinding specimens, and for his many suggestions and constructive criticisms toward the successful completion of the research.

THE EFFECT OF FLINT ON THE MODULUS OF ELASTICITY OF A SOFT-FIRED MATERIAL[1]

By C. G. Harman

ABSTRACT

The elasticity of quartz varies markedly with temperature, with an abrupt break at 573°. This paper is the result of a few preliminary tests to ascertain the effect of quartz on the elasticity of a ceramic material. The results seem to indicate that the elasticity of a ceramic body is not dependent upon the nature of the nonplastic present.

I. Introduction

It is a well-known fact that all the properties of quartz are changed during the passage from one form to another. R. B. Sosman[2] points out that the modulus of elasticity of quartz varies with temperature, as is shown in Fig. 1. It was thought that this property might be carried over in a ceramic body containing quartz. If such abrupt changes in the modulus of quartz do impart similar properties to the body of which it forms a part, the body would, of course, be seriously weakened at that temperature.

It was the object of this experiment to determine the relation between the modulus of elasticity and temperature, and how they vary with quartz content.

A fine-grained, very plastic Iowa shale was used in the test. The samples were prepared with no flint, 5% flint, and 15% flint added to the shale. Bars approximately $^1/_4$ by $^3/_4$ by 9 inches were made, carefully dried, and fired to cone 02. The bars were then fixed in a furnace and the deflection measurements were made.

II. Results and Conclusions

Figure 2 in no respect resembles Fig. 1, the elasticity-temperature curve for quartz. There is a slow but steady increase in the modulus as the temperature increases. At about 700°F the rate of increase in the modulus increases. The only logical explanation for this seems to be that the quartz has begun to undergo volume changes, which set up stresses in the clay surrounding it. This initial stress would, of course, add to the applied stress, with a corresponding effect on deflection.

The point of importance to be gained from this experiment is that after a certain amount of quartz is added to a body, the effect on the modulus is marked. The modulus is higher with higher amounts of flint. This is probably contrary to what would be expected. This fact, however,

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Heavy Clay Products Division). Received December 15, 1930.

[2] Sosman, Properties of Silica, p. 466. Chemical Catalogue Co., 1927.

suggests information of prime importance. That is, in a soft-fired product, nonclay, nonsintering grains have the effect of reducing the effective cross-section. In other words, when these nonplastic grains are present in a clay beyond a certain amount, the stresses in the body act much the same way as if there were voids present instead of grog grains. The foregoing statement excludes the effect of volume changes of the grog on the stresses in the clay surrounding them. But at constant temperatures it is seen that the modulus increases with increasing grog content, while it is known that the strength decreases. This seems to indicate that the major part of the stress is taken up by the clay.

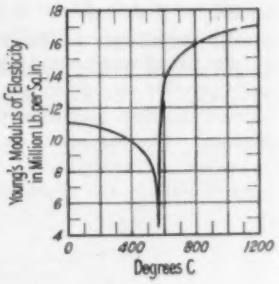

FIG 1.

III. Summary

A soft-fired body of clay and quartz does not have a similar modulus of elasticity-temperature curves to that of quartz. Within limits, the modulus of a body depends on the size and amount of grog and not on the kind of grog. A certain amount of grog may be added to clay without affecting the elasticity of the body appreciably. After a certain amount of grog is present, further addition has an effect on the modulus of elasticity similar to an equal volume of voids.

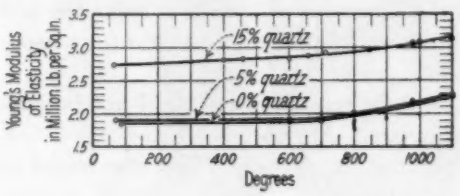

FIG. 2.

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THE REMMEY FUSION TEST FURNACE[1]

By G. Bickley Remmey

ABSTRACT

A fusion test furnace which can produce results up to cone 37 with less than 1/4 of a cone error is described. A reducing atmosphere around the cone plaque, which is the most frequent cause of faulty results in other fusion test furnaces, has been eliminated by (1) the use of oxygen and acetylene gases and (2) synchronized valves which automatically provide an oxidizing atmosphere in the furnace at all times. The temperature around the cone plaque is remarkably even due to the ample circulation of gas in the furnace. The furnace is built in one portable unit weighing 145 pounds. It is easy to operate. The fusion test furnace should be a valuable instrument for making routine control tests in the plant as well as for making precision tests in the laboratory.

I. Introduction

The fusion point of raw materials has a direct bearing on the quality of the finished brick. In order to conduct fusion tests it was necessary to secure a furnace with the following qualifications, before the pyrometric cone equivalent (P.C.E.) tests could be successfully adopted as a standard of control: (1) ability to show the true P.C.E. value by maintaining a slightly oxidizing atmosphere throughout all tests; (2) ability to duplicate tests by the use of superior regulating devices; (3) ability to make the test to at least cone 34 in less than two hours; (4) portability; and (5) reasonable operating costs.

A furnace that would meet all of these requirements could not be purchased, so it was decided to construct one. After studying its possibilities, the best combination of gases to produce the necessary heat was found to be oxygen and acetylene gases. Furthermore, the accessibility of these gases seemed to promise a wide usefulness for the type of furnace to be constructed.

II. Construction

The entire furnace weighs 145 pounds, and is built on a metal table with an asbestos top. It is one portable unit and can be carried from place to place as readily as the oxygen and acetylene tanks. The hose connections are the same as those on an oxyacetylene torch so that the hose may simply be screwed off of a torch and on to the furnace in a few seconds.

The body of the furnace is built (1) to withstand the temperature required to bring down cone 37, and (2) to prevent the loss of heat, thereby keeping the outside of the furnace cool and pleasant to work around.

As shown in Fig. 2, the metal shell (*A*), supports the inner construction and makes it rigid. Adjacent to the inside of this shell are (*a*) 3/4 inch of

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Refractories Division). Received December 15, 1930.

asbestos, (*b*) then $^3/_4$ inch of infusorial earth, and finally (*c*) the permanent lining of good insulating highly refractory fire clay which is $1^1/_2$ inches thick (*D*).

The inner and removable lining (*E*) is made of electrically-fused alumina. If the furnace is not frequently heated past cone 35, this inner lining will last for many months and even when it is eventually damaged, it can easily be replaced with a new one, since it is made in parts which fit in place without the need of cement or mortar. The furnace lid (*G*) along with

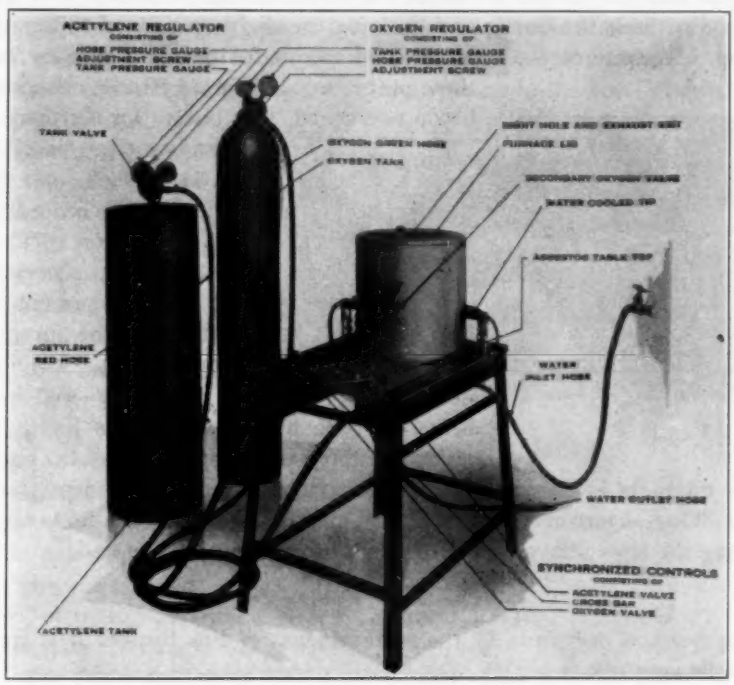

FIG. 1.—Remmey oxyacetylene test furnace.

inner covering (*H*) is made to carry out the same general construction as the furnace wall, that is, with asbestos on the outside, fire clay on the inside, and with the inner cover of electrically fused alumina facing the furnace heat. The center post (*F*) is in the center where most of the heat is concentrated.

The first center posts were made of silicon carbide. These held their shape, but the silicon carbide dissociated, leaving silica all over the sides of the post, and when the furnace was heated past cone 33 the dissociation of the silicon carbide became so rapid that the fumes of silicon would attack the test cones. Electrically fused alumina such as composes the

inner lining, was then tried, but when the furnace reached cone 32 these center posts collapsed. Of course, when cone 32 on top of this post was reached, the temperature of the post directly opposite the opening *K* (Fig. 2), where the gases enter, was at least four or more cones higher.

Fortunately zircon (zirconium silicate) proved to be an ideal material for this use. Its fusion point is approximately 4600°F and it has a good reputation for resisting sudden changes in temperature. After finding a way to manufacture center posts from pure zircon so that its chemical analysis showed over 98% zircon, the furnace could be heated as high as cone 38 without the center post showing the slightest signs of softening or fusing. In spite of the reputation of zircon for resisting spalling, after these posts have been used 10 to 15 times they become cracked too badly for further use. This is not a serious disadvantage, since these posts can be made for $1.00 each, and when the furnace is not going to be heated past cone 31, either silicon carbide or corundum posts can easily be substituted, successfully and more economically. At the present time the maximum temperature of the furnace is limited only by the inner electrically fused alumina lining which holds up well under heats to cone 37. If the inner lining were made of zircon, the temperature of the furnace could no doubt be carried much higher. The author is confident that an inner lining of zircon could be made, but as there has been little need of making the tests above cone 37 this has not yet been attempted.

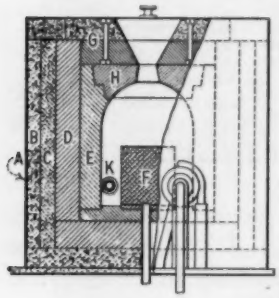

FIG. 2.

III. Fuel

Oxygen and acetylene fit the requirements of this furnace best for the the following reasons:

(1) They are most uniform. The oxygen supplied in tanks is over 99% pure and the B.t.u. value of acetylene is always about 1650.

(2) These gases are accessible everywhere in the United States and in many other countries.

(3) The oxyacetylene flame is the hottest in commercial use. It has a temperature over 6000°F.

(4) The small volume of this gas required to heat a furnace makes it possible to build one which will maintain perfect combustion and an evenly heated test chamber at temperatures high enough for all P.C.E. tests. This will be explained in detail later, when the action of the furnace gases is discussed.

IV. The Control System

The regulators shown in Fig. 1 on their respective tanks have long been

perfected for use with oxyacetylene cutting and welding torches. By their use a uniform pressure of 10 pounds and 16 pounds per square inch may be held in the acetylene hose and oxygen hose, respectively. The gases, which as before mentioned are most uniform in quality, pass through the hose under these standard pressures to the synchronized valves. (See Fig. 3.)

One of these valves regulates the flow of oxygen and the other the flow of acetylene. The handles of these two valves are connected by a bar so that the moving of one valve handle will always move the other valve an equal distance. The inner construction of the valves is such that the opening, through which the gas passes, increases, or decreases in direct proportion to the distance the valve handle is moved. The opening in the oxygen valve is made sufficiently larger than the opening in the acetylene valve, to allow the entrance of sufficient oxygen into the furnace to produce a slightly oxidizing atmosphere at all times. Consequently, these synchronized valves may be moved to any position, and yet a slightly oxidizing condition will always be maintained in the furnace.

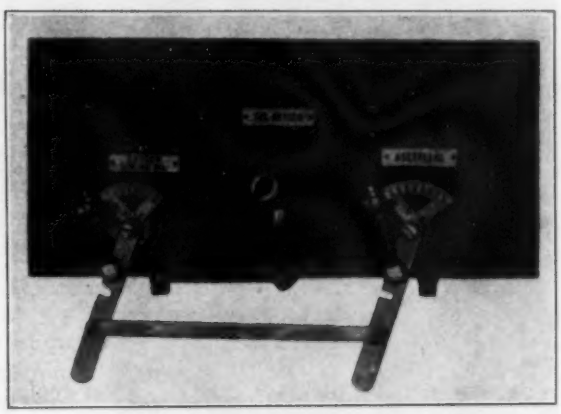

FIG. 3.—Synchronized valves.

The synchronized valves are also equipped with gages which show their exact position. By making a record of the valve settings including the time each setting is made, and then following this record, it is easy to duplicate tests with accuracy without the use of a pyrometer.

The features of these valves which make them suitable for this use are as follows:

(1) The increase in volume of fuel passing the valve is proportional to the turning of the valve stem, because the tapered V-shaped grooves on the circumference of the plug provide an increasingly larger opening as they are turned past the side of the valve. (See Fig. 5.)

(2) The capacity of the valve is adjustable to the furnace demand. These adjustments are made before the furnace is put into use.

(3) Vibrations or long use will not affect the valve adjustment, since the key shown in Fig. 4 adjusts the valve by means of a finely-threaded screw (*M*), and also locks the valve lever in position at (*N*).

(4) The degree of valve opening is visible at all times by the gages shown in Fig. 3.

(5) Leakage is prevented as the stem is gland packed.

(6) An inverted nonseizing plug is ground-fitted in the valve body and is held in uniform tension from below by means of the spring (*O*) shown in Figs. 4 and 5.

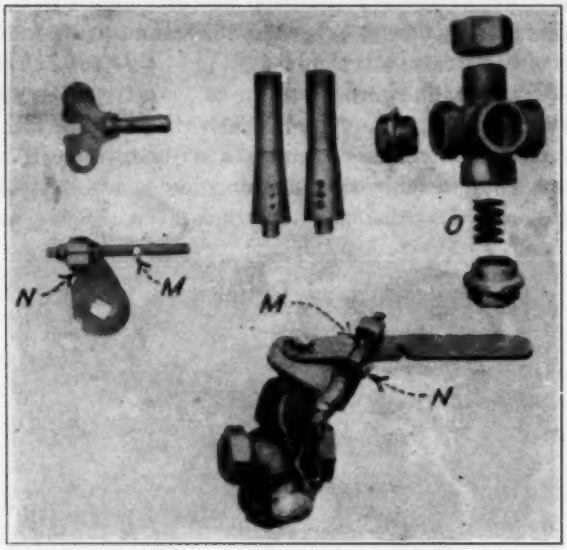

FIG. 4.—Valve parts.

From the synchronized valves the gases pass to the mixer which is on the under side of the table top. It consists of the same parts that do the mixing in a welding torch. Thus the mixer, like the regulators, is a perfected article.

The mixed oxygen and acetylene then pass from the mixer through copper tubing to the water-cooled tips. (See Fig. 1.) As long as a small amount of water is circulating through these tips they are kept cool, preventing back-fires and the melting of the ends of the tips which are near the furnace heat.

The valve in the center, shown in Fig. 3, is the secondary oxygen valve and is a great convenience when one is lighting the furnace. It allows oxygen to enter the furnace through the holes in the bottom of the center post, shown in Fig. 6. It can also be used to introduce additional oxygen during the test, when a highly oxidizing atmosphere is desired.

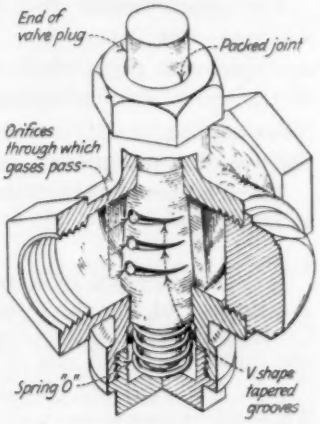

FIG. 5.

V. Action of Furnace Gases

Through a small hole in each water-cooled tip the mixed gases, under high pressure, are injected into the furnace

at tangents to the circular combustion chamber. (See Figs. 6 and 7.) This inrush of gases sets up a very rapid rotating action around the center post, and due to the small volume of gas required to heat the furnace, the gases continue to circulate around the center post for many cycles, before being forced up to the height of the test cones by incoming gases at the bottom. Consequently, before the gases come in contact with the test cones, they have had sufficient circulation to produce an even heat all around the cone plaque, and have also had ample time to permit perfect combustion of the oxygen and acetylene.

As before mentioned, this accomplishment is only possible with oxyacetylene fuel. For example: If a fuel such as city gas were used, the volume of gas and air required to heat the furnace high enough for the highest P.C.E. tests, would be so much larger that the gases would be forced through the furnace too rapidly to allow time for complete combustion. Of course, this congested condition would produce a reducing atmosphere and, therefore, doubtful results. At lower temperatures a city gas furnace can maintain perfect combustion, but as the volume of fuel is increased to reach higher temperatures, reducing conditions develop.

FIG. 6.—Showing some of the parts of the inner corundum lining with center post and cone plaque set in position. The cone plaque shown has cones 20, 26, 27, 28, 29, and 30 on each side. Note the evenness of the cones on both sides. This cone plaque is representative of the results which can be had in less than one hour.

The Remmey furnace has only one opening; a hole in the top $^3/_4$ inch in diameter serves for a sight-hole as well as an outlet for exhaust gases. (See Fig. 2.) The holes through which the two water-cooled tips and secondary oxygen line pass are sealed with high-temperature cement to prevent the entrance of cold air or loss of hot gases. One might think from this that the hot, exhaust gases blowing out the sight-hole would prevent close observation of the cone plaque. But this is not the case, as the gases are rotating so rapidly and blowing out so slowly that they dissipate with-

out the slightest interference to the observer, even if the eye is but six inches from the opening.

VI. Operation

The operation of the furnace is so simple that any practical man in a factory can learn it in a short time. To light the furnace, the oxygen and acetylene tank valves are opened and the hose pressures adjusted to sixteen and ten pounds, respectively. Then the secondary oxygen valve is opened. The furnace may then be lighted by simply dropping a burning match into the bottom and turning on the synchronized valves. In a few minutes the secondary oxygen valve is closed, and from then on the furnace is controlled entirely by the synchronized valves.

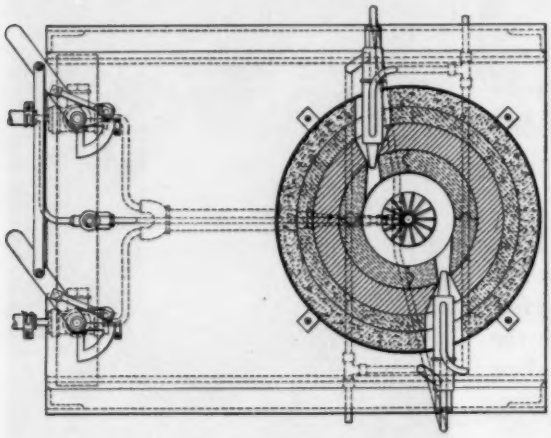

FIG. 7.

Let us assume that a fusion test following the heat curve specified by the standard P.C.E. method is to be made: After lighting the furnace, the synchronized valves would be placed at 55. In about forty-five minutes cone 20 would come down and the synchronized valves would then be turned back to 49 and the remaining cones would melt down in about the specified time. Every furnace should act in exactly the same way with respect to the synchronized valve readings. Although it has been a difficult task, all furnaces which have been constructed have been adjusted to match the standard furnace.

If the standard P.C.E. test is run to cone 32, the furnace will consume about two dollars worth of gas. This fuel cost, however, can be greatly reduced by using a portable acetylene generator. While this fuel cost may seem a trifle high, it must be considered that with this furnace it is possible to make many tests which heretofore could not be made in the short time required, or because a sufficiently high temperature could not be reached while the atmosphere in the furnace was kept safely oxidizing.

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WELDED ZIGZAG WINDINGS AND REFRACTORY SHAPES FOR HIGH-TEMPERATURE FURNACES[1]

By Louis Navias

ABSTRACT

A brief account is given of published methods for making high-temperature furnaces using W and Mo windings, placed both internally and externally with respect to the furnace tube.

Several new methods of furnace construction are here mentioned:

(1) A furnace tube may be built up of a series of rings made of refractory substances for external windings.

(2) A furnace tube may be built up of a series of tall and flat rings, alternately placed, made of refractory substances for an internal winding, the winding being threaded through small holes drilled in the flat rings.

(3) A zigzag winding with welded joints has been developed for W and Mo wire.

The winding may be conveniently sheathed with refractory tubes, as the winding runs the length of the furnace tube.

The entire zigzag winding may be put in series, or divided into a split parallel winding, each type having its own advantages and faults.

(4) Details of windings and refractories for furnaces reaching 1600°C and 2000°C are given. Windings are protected from oxidation by hydrogen.

I. Introduction

As early as 1911, Winne and Dantsizen* reported on the use of ductile tungsten (W) and molybdenum (Mo) as furnace windings of the metal resistance type, using hydrogen gas to protect the windings from oxidizing. Since then there have been a number of papers† published describing the use of Mo wire on refractories like porcelain and "alundum." Mo wire can be obtained in long lengths and ductile enough to be wound on a furnace tube at room temperature without much difficulty. Another advantage of the Mo wire is that wires of 60 mils or greater diameter can be twisted together for the purpose of holding the winding in place at the ends of the tube. W wire is generally far less ductile, and to obtain a winding of 60-mil wire it is necessary to heat the wire during the winding process and accompany it with a hammering operation to give form to the winding.

Up to temperatures of 1650°C, the available commercial materials of Mo wire and "alundum" refractory tubes are quite satisfactory. A typical installation is a horizontal furnace with an "alundum" tube 24 inches long and 3 inches inside diameter, wound with 60-mil Mo wire, $3\frac{1}{2}$ turns per inch over 20 inches of the tube. Such a furnace will have a life of six or more months with daily firings from 1600 to 1625°C. The winding becomes brittle on continued heating and smaller in cross-section.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Refractories Division). Received December 4, 1930.

* See reference 1, p. 375.

† See references 2, 4, and 5.

After eight months a 60-mil Mo winding was found to measure 58 mils in the hot zone. Above 1650°C both the Mo and "alundum" become unsatisfactory, for the Mo windings begin to vaporize and the "alundum" begins to soften and also becomes electrically conducting. As vaporization of Mo continues (especially above 1800°C), the wires become smaller and cause a change in the characteristics of the furnace. A more serious factor is the deposition of Mo crystals on the refractory between turns of the winding helping to "short" the winding. Around 1700°C, the "alundum" softens perceptibly and conducts electricity. For higher temperatures than 1650°C it is necessary to use a W winding with high-melting refractories.

Engle* notes that Mo is far more volatile than W when heated to high temperatures. His data for the vapor pressure of these elements are given at the end of this paper in conjunction with other properties of the elements.

Miller and Lindeman† state that the destruction of Mo resistors in electric furnaces is due chiefly to chemical reaction with materials present in the heating tubing, the insulation, or gases in the furnace. They consider from experimental evidence silica and carbon to be the most destructive. Mo ribbons were heated in contact with tubes made of alumina, magnesite, Marquardt porcelains of different grades, and a mixture of alumina and kaolin, the experiments being made in vacuum and in a hydrogen atmosphere. The Mo ribbons, coming in contact with high silica-containing mixtures, showed distinct signs of corrosion, whereas contact with the magnesite (which contained some carbon) only hardened the ribbons, and other materials left them ductile. The presence of C and carbon-containing gases caused Mo ribbons to become hard and brittle, whereas water gas, sulphur, sulphur dioxide, water vapor, nitrogen (free of oxygen) made no changes in the condition of the Mo.

Fahrenwald‡ described a small furnace using 10-mil W wires stranded together, the composite wire being wrapped around a refractory tube in a spiral.

Fehse§ made a fine contribution in his work on making furnaces with the spiral of W wire on the inside of the furnace tube. The technique was as follows:

A core of aluminum metal was made, threaded throughout its length with a smooth spiral. On the outer edge of the thread a groove was cut to hold the W wire, which was wrapped around the core in spiral form. Around the core was then tamped highly-fired oxides like fused alumina

* See reference 3, p. 375.
† See reference 4.
‡ See reference 5.
§ See reference 6.

or zirconia to form the refractory tube of the furnace. As soon as convenient the aluminum core was removed by unscrewing it, leaving the W-wire spiral held in position by the refractory tube. The furnace was baked and fired by heating the winding internally. For a furnace to reach 1800°C, Fehse used two W wires, 0.6 mm. (24 mils) in diameter, the furnace having 45 turns and a hot zone 46 cm. (18 inches) long and 3.9 cm. (1.5 inches) in diameter with an input of 170 volts and 23 amperes. The winding was protected by a flow of a gas mixture of H_2 and N_2. The refractory was made of fused alumina. To reach 2000°C in a horizontal furnace or 2200°C in a vertical furnace, Fehse made a furnace with heating zone 40 cm. (16 inches) long and 4.6 cm. (1.8 inches) in diameter. The winding consisted of two W wires, 0.8 mm. (32 mils) in diameter with 31 turns, protected with the same gas mixture. For 2200°C, the electrical consumption was 152 volts and 40.5 amperes. The refractory was made of zirconia fired to 2000°C. Other modifications of furnace design with the winding on the inside of the refractory are also given.

Cohn* has described several furnaces using W wire as the winding and zirconia (ZrO_2) as the refractory. He made furnaces with internal windings and furnaces with external windings. For the internal winding Cohn made the spiral on a brass core, which could be easily removed when necessary. The spiral of W wire is plastered with a mixture of high-fired and low-fired ZrO_2 (1:1 mixture) made into a paste with dextrin and water. On drying, the core and winding are slipped into a fired tube of ZrO_2 and the space filled with ZrO_2. After the ends have been filled the collapsible brass core is removed. MgO is used as a furnace packing around the ZrO_2 tube. A furnace 15 cm. (6 inches) long and 1.6 cm. (0.63 inch) inside diameter with a hot zone of 4 cm. long will reach 2000°C with a W winding 0.5 mm. (20 mils) diameter spaced 2 to 3 mm. apart, drawing 8 amperes at 110 volts. For the external winding type of furnace Cohn placed the W spiral winding between two tubes of ZrO_2. The W spiral is made by winding the heated W on an iron mandrel. The dimensions of such a furnace are inner ZrO_2 tube 17 cm. (6.7 inches) long and 2 cm. (0.79 inch) inside diameter. The W spiral was made of 0.5 mm. (20 mil) diameter wire and spaced 2 to 3 mm. apart. The outer ZrO_2 tube was surrounded with ZrO_2 powder held in place by a water-cooled outer refractory tube. A temperature of 2000°C was reached with 110 volts and 15 amperes. The windings were protected by a gas mixture of H_2 and N_2. It should be noted that the furnaces made by Cohn are much smaller than the furnaces made by Fehse.

II. Present Work

The work recorded here has been in progress over a period of two years, undertaken to obtain furnaces capable of reaching high temperatures, for the object of firing substantially large charges of powder and large

* See reference 7.

shapes, necessary for other investigations. As the literature was referred to only after all the methods described hereafter were fully developed it is evident that no attempts were knowingly made to produce high-temperature furnaces in a different manner than described elsewhere.

(A) Mo Spiral Winding and MgO Refractory Tube Horizontal Furnace with External Winding

The MgO refractory tube was made up of a number of tall MgO rings $2^3/_8$ inches inside diameter and $3^1/_4$ inches outside diameter and about $2^1/_2$ inches high (Figs. 1, 2, 3, 4). The rings were made by pressing in a mold MgO powder (previously fired to 1650°C) with a small quantity of organic binder. The rings were then fired to 1650°C in a vertical Mo-wound "alundum" tube furnace using hydrogen to protect the winding. The rings were mounted on a horn fiber tube, and the 60-mil Mo winding put on 3 turns per inch for a 24-inch section, an extra inch of refractory being bare at each end. The bare wires were plastered with MgO powder (previously fired), wet with water and an organic binder. Round rods of MgO (fired to 1650°C), $^3/_4$ inch in diameter and about 8 to 10 inches long, were set in the plaster to act as ribs, more MgO plaster being used to round out the shape. The refractory shape was then put in a horizontal position in the furnace casing with fired alumina powder as the insulating material. Internal heating by means of the Mo winding dries out the MgO plaster and chars the fiber tube which may then easily be removed in sections. 1900°C was reached with 32 amperes and 200 volts. A rheostat was maintained in series with the winding, and as there was reserve resistance higher temperatures could have been reached. After several runs conduction across the winding was noticeable, especially at the higher temperatures, and the conduction became quite pronounced in the later runs. Examination of the winding near the center of the furnace showed the crystals of Mo between the turns. Assuming a temperature drop of 200 to 300° across the thickness of the refractory tube, the Mo must have been heated well over 2100°C. Several furnaces of essentially the same construction and materials were made and they behaved in identical fashion, giving high temperature and fine control, but short life.

(B) W Zigzag Winding and MgO Refractory Tube Horizontal Furnace with External Winding

(1) Zigzag Welded W. Winding

Several attempts were made without success to obtain long lengths of W wire uniform and ductile enough for these furnaces. Heating the wire was also considered and abandoned. Finally the zigzag welded winding was developed and found satisfactory. For the furnace shown in Fig. 1,

W wire 60 mils in diameter was cut into lengths $22^1/_2$ inches long. The wires in pairs are bound together at one end with a length of Mo wire 10 to 15 mils in diameter. These joints are then permanently fixed by a welding process in which the joint is made one electrode and another piece of W wire the other electrode. A high resistance in series with the work on a 250-volt line is required. The joint is protected from oxidation by making the weld in a flame of burning hydrogen obtained with a Bunsen or Fisher burner. Part of the Mo wire wrapping is amalgamated with the weld during the process. The winding lengths are fitted with refractory sleeves if necessary and mounted on the refractory furnace tube. The loose ends are then coupled and bound together in the order required with the fine Mo wire, and the junctions welded in place. Heavy Mo leads are welded to the winding in the same way. As the winding is held in place by rubber bands only, it may be moved bodily on the tube for the welding operation. The winding may be plastered with refractory material and bolstered with refractory rods as described above.

(2) Zigzag Series Winding With the zigzag winding it is possible to obtain several modifications. If the winding is made so that the entire length is in series, the high-potential drop comes between the two adjacent lengths of the winding attached to the lead wires, whereas the potential drop between all other adjacent lengths of winding is relatively small. Unless the refractory at high temperatures is relatively nonconducting, and unless the space between the two adjacent lengths carrying the maximum voltage is made great, there may be difficulty from partial conduction across this gap at the high temperatures. This matter will be discussed later.

(3) Zigzag Split Parallel Winding A zigzag winding can be made as a split parallel winding in which the voltage drop between any two neighboring lengths of winding is relatively low. From the incoming lead, the furnace winding is divided into two separate windings, each in zigzag style, and these two windings meet at the outgoing lead on the opposite side of the tube. The leads may

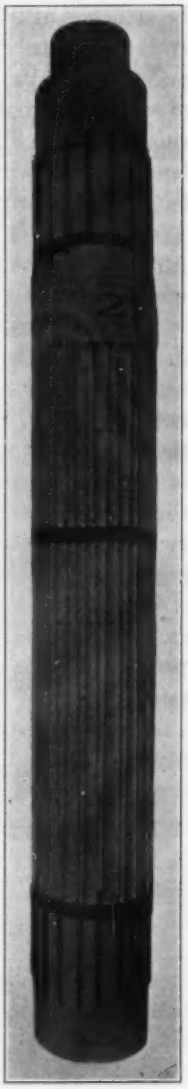

FIG. 1.—W wire zigzag split parallel winding; MgO refractory tube made of rings; horizontal furnace with external winding.

be attached at the same end of the tube (but at opposite sides) or at opposite ends of the tube. With a split parallel winding of this kind it may be necessary to have more winding length present and probably a winding of smaller diameter wire in order to lower the current-carrying capacity of the winding. Figure 1 shows a zigzag split parallel winding made of 36 lengths of W wire, $22^1/_2$ inches long and 60 mils in diameter. Eighteen lengths (or nearly 34 feet) of wire were in each side of the parallel winding. Temperatures of 2000°C are readily obtained with 115 volts and 80 amperes. Alumina (melting point 2050°C) placed in a closed Mo boat was melted and made fluid enough to flow into crevices in the boat and leave elevated spots in the boat bare. Petrographic examination of the fused alumina showed it to be entirely corundum crystals. A furnace run fifteen times shows very slight electrical leakage at the maximum temperatures, which does not interfere with the running of the furnace. At these high temperatures the MgO of the furnace tube vaporizes and condenses at the colder parts of the tube; hence it is desirable to cover the samples being fired. The slight haze in the furnace due to the vapor may interfere with the exact measurement of temperature by means of optical instruments, the temperatures read being usually lower than the actual temperatures. While it is known that an intimate heating of W and MgO in a vacuum will cause the MgO to lose its oxygen and deposit metallic Mg, it has also been shown in practice that a W filament or wire in contact with a MgO refractory does not react to the extent that might be inferred. Ordinarily the MgO closest to the wire will shrink and vaporize due to the high heating and recede from the wire. Other oxides could be used for the furnace refractory tubes but MgO was used in this work as it was available in pure form and in some quantity.

(C) Zigzag Winding and MgO Refractory Tube Vertical Furnace with Internal Winding

The refractory furnace tube was made of tall MgO rings, $2^3/_8$ inches inside diameter $3^1/_4$ inches outside diameter, and about 2 inches high, and of flat MgO support rings, 2 inches inside diameter, $3^3/_8$ inches outside diameter, and $^1/_4$ inch thick. Both types of rings were made of prefired MgO by pressing in metal molds and firing to 1650°C. The flat support rings were drilled with sixteen holes in a circle of $2^1/_4$ inches diameter. In the furnace the tall and flat rings alternate, and the winding is held in place inside the tube proper as it is threaded through the holes.

(1) Mo Wire Zigzag Series Winding

In one attempt Mo wire was threaded through these holes giving a winding of 24 feet (16 lengths of 18 inches each) (Fig. 2 and Fig. 3). The maximum potential drop occurred between two adjacent lengths, which

at a temperature of 1650°C in the furnace amounted to 160 volts. The winding burned out at this temperature on the first run. A post mortem examination of the hot zone indicated that the burn-out had occurred between the adjacent wires carrying the maximum potential. The furnace wall just behind the Mo winding carried streaks of Mo crystals

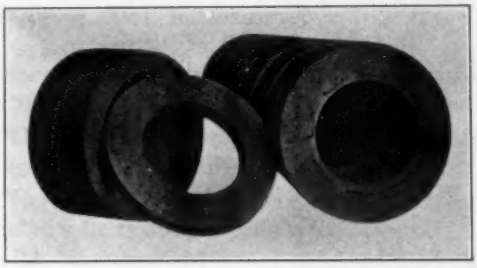

FIG. 2.—Mo wire zigzag series winding; MgO refractory tube made of tall and short rings; vertical furnace with internal winding.

FIG. 3.—For legend, see Fig. 2.

paralleling the winding, a condition which had been noticed in a furnace of somewhat similar construction made previously.

(2) W Wire Zigzag Split Parallel Winding

W wire was used in lengths of 20 inches, there being 16 lengths of 35 mils diameter. These lengths were welded at the ends in the manner described above. The winding was split so that there were 8 lengths in each side of the parallel winding (Fig. 4). The ensemble of tall and flat rings with the internal winding was packed in an "alundum" tube with prefired MgO. The "alundum" tube, 6 inches inside diameter, had a separate spiral winding of 60-mil Mo wire, with which to heat the surrounding insulation. This outer winding was not necessay but was used as it had already been installed in a furnace casing. With current flowing through the outer furnace unit, no visible color was detected in the furnace chamber proper after several hours of heating alone. Temperatures of 2000°C were easily obtained in the zigzag furnace in $2^1/_2$ to 3 hours with 100 volts and 48 amperes. A number of runs with the furnace has shown how well it behaves without trouble from conduction. Unfortunately

the vertical furnace does not lend itself well to experimental work where it is desirable to remove or shift the sample, especially when there is the danger of supports, boats, tongs, and the like coming in contact with the hot winding. For these reasons only has the vertical furnace with internal winding been neglected.

(D) Zigzag Windings for Furnace Temperatures of 1600 to 1700°C

As the zigzag windings had worked so well on the furnaces reaching 2000°C, it was decided to determine whether there would be any advantages in applying this type of winding to furnaces now run fairly successfully with spiral windings of Mo wire on "alundum" tubes. Hydrogen is used to protect all windings.

FIG. 4.—W wire zigzag split parallel winding; MgO refractory tube made of tall and short rings; vertical furnace with internal winding.

(1) Mo Wire Zigzag Series Winding. External Winding on Horizontal Tube Mo wire of 60-mil diameter in 20-inch lengths was welded into a zigzag series winding with 36 lengths in series. The lengths were sheathed with pure alumina tubing, as shown in Fig. 5. The "alundum" furnace tube is 3 inches inside diameter, $3^3/_4$ inches outside diameter, and 24 inches long. A space of 1 inch was maintained between the two high potential leads and when the tube was laid in the furnace casing, this space was placed on top. The winding and furnace tube were packed with fired alumina powder, no plastic material being used. This furnace had a long life at temperatures of 1650 to 1700°C and showed no conduction to ground, that is, from the inside of the furnace tube to the metal casing if *shorted* by a metal rod like a poker. This condition was probably due to the fact that a zigzag winding can be sheathed with good insulators, whereas a spiral winding cannot be so readily protected. The length of the hot zone proper is about the same for this zigzag furnace as for a spiral wound furnace with Mo winding of 60-mil wire, with $3^1/_2$ turns per inch wound over 20 inches of refractory. In spite of the space at the top of the furnace between the two lengths with the maximum potential drop between them, the furnace showed no cold spots. The electrical input for 1650°C is around 35 amperes at 180 volts.

(2) W Wire Zigzag Series Winding. External Winding on a Horizontal Tube Another furnace has been built similar in all details to the one described above, except that the winding is made of W wire, 60 mils in diameter. The heating characteristics are so far very similar.

(3) Mo Wire Zigzag Series Winding. External Winding on a Vertical Tube A furnace which is of use in the firing of powder charges is made with a vertical "alundum" tube 6 inches inside diameter and 18 inches high. A zigzag series winding was tried with 57 lengths of Mo wire, 15 inches long and 60 mils diameter, with a two-inch gap between adjacent lengths carrying the high potential. The winding was covered with pure alumina insulators and the furnace packed with fired alumina. The winding required 200 volts and 32 amperes to reach 1700°C. The furnace was abused by maintaining it for long periods at high temperatures and was burned out in 15 daily runs.

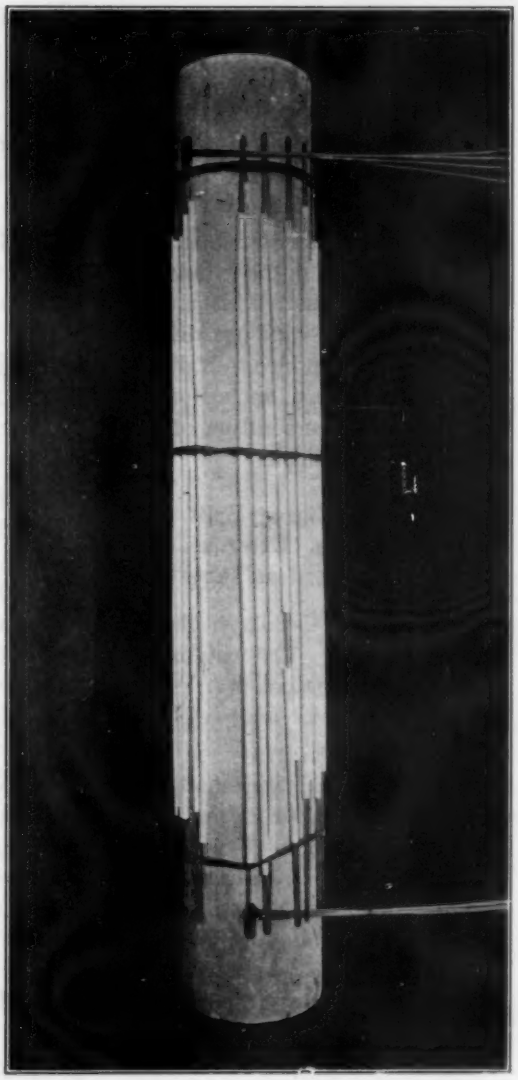

FIG. 5.—Mo wire zigzag series winding; "alundum" refractory tube; horizontal furnace with external winding.

(4) Mo Wire Zigzag Series Winding. External Winding on a Vertical Tube

A difficult furnace to maintain is one 6 inches in diameter and 12 inches high. Probably the best results with a spiral winding were obtained with a 50-mil Mo winding wound on an "alundum" tube, 3 turns per inch over a length of 11 inches. This furnace requires 28 amperes and 220 volts to heat it to 1600°C.

Due to the relatively short height of the furnace tube, the number of zigzag winding lengths becomes large, and hence the number of welds becomes large also. This is a decided disadvantage, particularly with the split parallel windings discussed below. A series winding was made for this furnace (6 inches in diameter and 12 inches high) using 77 lengths of 60-mil Mo wire, 11 inches long, leaving a 2-inch gap for the high-potential insulation. A temperature of 1600°C is reached in a few hours with 33 amperes and 190 volts.

(5) Mo Wire Zigzag Split Parallel Winding. External Winding on a Vertical Tube

For the same furnace, with an "alundum" tube of 6 inches inside diameter and 12 inches high, a split parallel winding was made with 110 lengths of Mo wire, 11 inches long and 45 mils in diameter, 55 lengths being in each side of the parallel winding. The winding is covered with alumina tubes and packed with fired alumina powder. A temperature of 1650°C was reached with 155 volts and 43 amperes. So far the furnace has stood up quite well.

Another winding was made with 40-mil Mo wire having 136 lengths of 11 inches each as a zigzag split parallel winding with 68 lengths in each side of the winding. The winding was covered with alumina tubes and surrounded by fired alumina. A temperature of 1650°C was maintained with 170 volts and 30 amperes. The winding burned out after 8 daily runs.

(E) Specific Resistance of W and Mo

Values for the specific resistance of Mo and W have been taken from the papers of Worthing* and Jones † to show that there is not much difference from the standpoint of practical furnace building between these two metals. The resistivities are for a specimen of metal whose dimensions at room temperature are one square centimeter in cross-section and one centimeter long.

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* See reference 8.

† See reference 9.

Temperature °C	°K	Specific Resistivity $\rho \times 10^6$ ohm, cm. Mo	W
0	273	5.14	5.00
20	293	...	5.49
27	300	5.78	5.65
127	400	8.15	8.06
527	800	...	19.00
927	1200	29.5	30.98
1327	1600	41.1	43.55
1727	2000	53.1	56.67
2127	2400	65.5	70.39
2527	2800	78.2	84.70
2927	3200	...	99.54
3327	3600	...	115.0

Other facts of interest regarding these two elements are taken from International Critical Tables, and the data on vapor pressure from Engle's paper.

	Mo	W
Melting point	2620°C	3370°C
Normal boiling point	3700°C	5900°C
Density	10.2	19.3
Vapor pressure	$6{,}430 \times 10^{-12}$ mm. at 1517°C	6.45×10^{-13} mm. at 1727°C

Acknowledgment It is a pleasure to acknowledge the assistance of M. R. Many and Y. Lundgren in this work.

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THE INSULATION OF GLASS-FURNACE REGENERATORS[1]

By R. M. Langley

ABSTRACT

The application of insulation to regenerator chambers whether existing or new has resulted in savings which exceed the calculated results, because insulation properly applied is effective in reducing air leakage, in giving more accurate combustion control, and of equal importance, the proper insulation as to amount and method of application has no possible ill effect on the refractories of the regenerators.

I. Introduction

Insulation has been used extensively in glasshouse practice, being applied with a high degree of satisfaction to hot gas mains, leers, day tanks, Fourcault drawing canals, and so forth, but due to the difficulties encountered in applying insulation to melting furnaces, attention has been diverted from the substantial savings which can be effected by insulating the regenerator chambers of such furnaces.

The radiation losses from glassmelting furnaces have long been recognized as accounting for a large percentage of the total heat losses involved in the operation of glassmelting equipment, and many attempts have been made to apply insulating materials to the surfaces of the sides and caps of furnaces. Records show that in some instances rather remarkable economies have been effected for short periods of time, but due to the high temperatures encountered, results have not been entirely satisfactory. Refractories of a greater life expectancy in the severe service of glassmelting tank service, however, are being introduced, so it would appear that it is reasonable to look forward with a degree of certainty to the time when refractory materials will be available which will permit the general application of insulating materials to glassmelting furnaces properly designed.

Actual results under operating conditions exceed to a marked degree the calculated savings, because insulation properly applied is very effective in reducing air leakage. Of equal importance, actual practice has proved that proper insulation both as to amount and method of application has no possible ill effects on the refractories.

The more important results obtained through the use of insulation on regenerators are (1) a saving in fuel per ton of glass melted, (2) improved and more closely controlled combustion due to the reduction in air leakage, and (3) increased production and increased temperatures of preheated air and gas.

All of these improvements have been obtained in varying degrees in a number of installations. In some instances, fuel saving has been the most

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apparent advantage, in others, the more positive control of combustion conditions, but in every instance the application of insulation has resulted in the accomplishment of highly desirable results and what is of equal importance, where insulation of the proper type and thickness was applied there was no detrimental effect on the refractories of the regenerators.

In a number of installations the full effect that may be obtained in insulating existing regenerators cannot be taken advantage of due to their inaccessibility. Many are built below ground level and, after building, earth has been filled in around the side walls. In such instances only the arches may be insulated but it has been proved, however, on open-hearth steel regenerators that in rebuilding walls as well as the bases of regenerator chambers, they can be economically insulated below ground level even though an air space is not maintained between the side walls and the surrounding soil.

II. Heat Losses from Uninsulated and Insulated Surfaces

Figure 1 shows the heat losses at temperatures encountered on the outside surfaces of uninsulated walls. This chart is convincing in itself, but there are instances where the radiating surfaces of chambers are well ventilated and these surfaces are relatively cool, yet the unit radiation losses are greater than in others where the chambers are in confined spaces without ventilation and when higher surrounding atmospheric temperatures prevail. Excessive air infiltration in some cases may result in wall temperatures which are low and misleading. Radiation losses in such instances may not be excessive but the loss due to air infiltration may be high and can be reduced if not entirely eliminated.

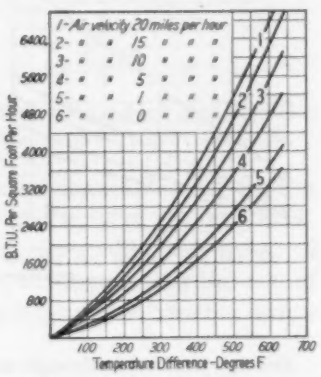


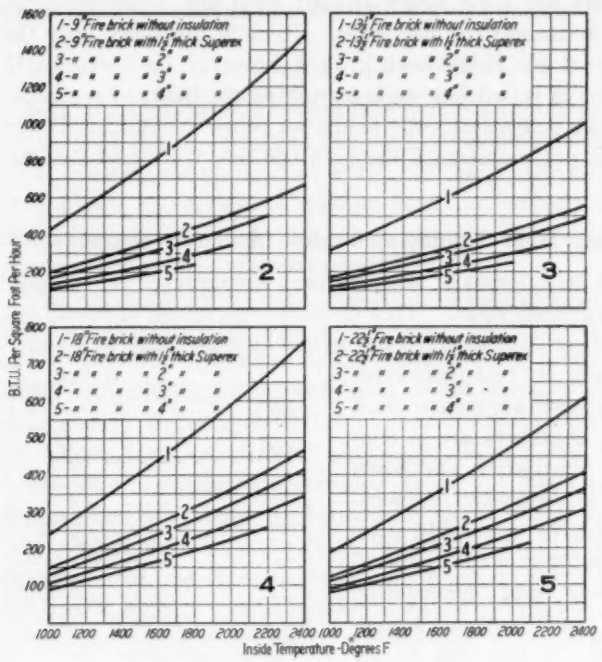
FIG. 1.—Heat losses from uninsulated hot surfaces.

Computed results are shown in Figs. 2, 3, 4, and 5, the figures being given for refractory thicknesses of 9 inches, $13^1/_2$ inches, 18 inches, and $22^1/_2$ inches without insulation and with several thicknesses of insulation in each case. In these computations, due to the fact that the conductivities of refractories vary considerably and in order that these figures may be conservative, conductivities of the lower values ranging from 6.0 B.t.u. per sq. ft. per degree temperature difference per inch thick per hour at a mean of 1000°F to 8.77 at 2600°F were used. Higher thermal conductivities of the refractories would result in correspondingly higher losses from uninsulated structures than those shown on these figures. The losses with insulation on such structures would be

increased but to a much smaller degree than for the uninsulated; therefore under such conditions the savings would be greater than shown on the charts.

III. The Value of Savings Effected by Insulation

The saving in radiation loss in B.t.u. per hour can be best expressed in terms of the savings in dollars per 100 sq. ft. per year. Figure 6 readily shows such values for various yearly operating periods and for different fuel or heat costs. As an example, from Fig. 2 it can be determined that with an average temperature of 2000°F on the inside surface of the 9-inch thick firebrick roof of a checker chamber the savings in B.t.u. per sq. ft. per hour with a 2-inch thickness of insulation is 690 B.t.u. Turning now to Fig. 6, if the regenerators are operated 7000 hours per year with a fuel cost of but 20¢ per million B.t.u., the annual savings per square foot per hour is found to be approximately $0.95, or $95.00 per year for 100 sq. ft. This annual saving is considerably more than the cost of the insulation so it can readily be seen that the saving thus secured will pay for the insulation in a few months time, after which the net saving is a clear gain. From a heat-saving standpoint using a greater thickness of insulation is justified,


1-9" Fire brick without insulation
2-9" Fire brick with 1½" thick Superex
3-" " " " 2" " "
4-" " " " 3" " "
5-" " " " 4" " "
1-13½" Fire brick without insulation
2-13½" Fire brick with 1½" thick Superex
1-18" Fire brick without insulation
2-18" Fire brick with 1½" thick Superex
1-22½" Fire brick without insulation
2-22½" Fire brick with 1½" thick Superex
B.T.U. Per Square Foot Per Hour
Inside Temperature - Degrees F
1000 1200 1400 1600 1800 2000 2200 2400

FIGS. 2, 3, 4, AND 5.

FIG. 2.—Heat losses through uninsulated and insulated walls and roofs; 9-inch fire brick (air temperature 80°).

FIG. 3.—Heat losses through uninsulated and insulated walls and roofs; 13½-inch fire brick (air temperature 80°).

FIG. 4.—Heat losses through uninsulated and insulated walls and roofs; 18-inch fire brick (air temperature 80°).

FIG. 5.—Heat losses through uninsulated and insulated walls and roofs; 22½-inch fire brick (air temperature 80°).

but other factors which will be discussed later have bearing on the effectiveness of the 2-inch thickness of insulation.

On side walls, thicker insulation may be used and the heat loss reduced to a more economical figure without danger to the refractories, inasmuch as the brickwork is thicker and the average temperature lower. The temperatures on the inside of the upper portions of the side walls are equally as high as the inside surface temperature of the roofs, but the elimination of insulation at the skewback and the flow of heat from the hotter to the cooler portions results in a lower mean temperature for those portions of the walls subjected to the highest inside surface temperatures. Figure 4 shows that the savings with 3 inches of insulation on an 18-inch thickness of firebrick wall with an average inside temperature of 1800°F is 280 B.t.u. per sq. ft. per hour, which is equivalent to a saving of $40.00 per 100 sq. ft. per year on the basis of 6000 hours yearly operation and a heat value of 20¢ per million B.t.u. This represents a return of approximately 88% on the investment which clearly indicates that a slightly greater thickness, perhaps 4 inches, could be economically used from a greater heat-saving standpoint and without impairment of the brickwork.

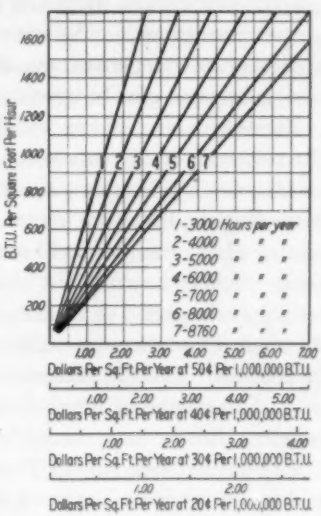


FIG. 6.—Cost of heat losses in dollars per year.

The savings effected by 4 inches of insulation can readily be determined from the chart and it is then only necessary to determine with the cost of the extra inch of insulation whether it will show a sufficient annual return to justify its being used.

IV. Using Total Furnace Fuel Cost as Basis for Expressed Savings

When the total fuel costs involved in operating a glass furnace are taken into consideration the saving of but 1% of this total figure represents a sizable expense item and when consideration is given to the fact that the radiation losses from uninsulated regenerators and uptakes has been variously estimated as accounting for from 6 to 8% of the total fuel consumption of the furnace, insulation so applied that will reduce this figure 50% should receive every consideration.

The percentage of the total fuel which may be saved by the use of insulation at times may be misleading and misinterpreted as it represents a relatively small percentage of the whole. A true perspective can be ob-

tained by comparing the annual saving with the annual cost of the means provided to effect that saving.

V. Reduction of Air Leakage with the Use of Insulation

By the correct application of the proper types of insulation to the accessible portions of the walls and arches of old regenerators and by making proper provision for the use of insulation on the surface of the walls and arches of new regenerators, air leakage through surfaces to which insulation is applied can be greatly reduced if not practically eliminated.

Excessive air leakage eliminates the possibility of accurate control of the amount of air introduced into the regenerators to be preheated for combustion. Dampers are provided for the purposes of controlling the incoming air, but with air infiltration through the walls any predetermined setting of the dampers will not assure the desired amount of air for combustion. It may be said that after a set of regenerators has been in operation for a certain period of time damper adjustments can be made to compensate for air leakage through walls of regenerators, but in order to do this it would be necessary to make frequent changes in damper settings because the tightness of uninsulated brick surfaces may vary under the changing temperature conditions encountered during the operating cycle of a regenerator.

Experience has shown that under heat conditions brick structures in general develop cracks or openings at joints, which in the case of regenerator structures would mean air leakage. Such cracks or openings can be calked or pointed up or a complete coating of the outside surfaces can be employed when such cracks are evident, but with insulation properly applied, an outside covering or sealing medium of a permanent nature is secured and the application of insulation to an uninsulated brick wall greatly reduces the possibility of further cracking or opening of joints by virtue of the fact that with insulation the entire mass of refractory making up the wall structure assumes a more uniform temperature condition than is the case without insulation.

The introduction of excessive air due to air leakage not only means more than the desired amount of air for combustion but heat in the regenerators must be provided to raise the temperature of the air entering through the brick structure.

The elimination of the heating of this excessive air by the reduction of air leakage and having available the heat required in many instances may alone justify the use of insulation.

VI. Application of Insulation to Regenerators

Satisfactory results have been obtained in applying insulation to both new and old regenerators and the approximate thicknesses of materials recommended has been mentioned previously. Particular installations,

however, would govern to some extent the economical thickness for the particular application.

On new regenerators insulation for the hearths and walls both above and below ground level as well as the arches has proved to be worth while. Over the arches a 2-inch thickness of block insulation applied in two 1-inch layers is recommended. For the side walls a 3-inch thickness of block insulation applied in two $1^1/_2$-inch layers is generally found to be most economical and for the hearths under the checkers an insulating concrete mat at least $4^1/_2$ inches thick should be used. The question may arise as to the effect on the refractories using the thicknesses of insulation recommended. Actual temperatures taken between the brickwork and the insulation of the side walls of a particular installation were less than 1200°F. These values clearly indicate the effectiveness of insulation in retarding heat flow, but at the same time they are such that the mean temperature of the brickwork is well within safe limits. The recommended thickness of 2 inches of insulation for the arches has not proved to be excessive. Actual temperature readings between the insulation and the refractories are such that the mean temperature of refractories is within safe working limits. Although temperatures directly under the arches are relatively high the period of maximum temperature is short in the cycle of regenerator operation with the result that only the inside surface of the brick is subjected to the maximum temperature and only a small portion of the brick undergoes a wide temperature variation. This is evident when temperature readings between the insulation and the refractories of the arches show no variation through the regenerative cycle.

With existing regenerators it is obvious that only accessible portions of the side walls and arches can be insulated.

VII. Conclusion

In conclusion it may be said that the benefits derived from the application of insulation to glass tank regenerators have been demonstrated by actual results on many installations on both old and new regenerators. The savings in fuel, the reduction in air leakage, the more accurate control of combustion, and the lack of deteriorating effects on the refractories with insulated regenerators are not assumptions or theories awaiting proof, but are actual accomplishments. It would, therefore, appear that regenerator insulation offers a field for effecting savings and improving operating conditions with methods which have been thoroughly proved as to their value and practicability.

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GRADING AND SAMPLING OF MISSOURI BURLEY AND DIASPORE CLAYS[1]

By C. R. Forbes[2]

ABSTRACT

At the present time there is no uniform terminology applied to Missouri high alumina clays. The terms burley flint, burley, and diaspore are suggested. Sampling methods are described and the adoption of a uniform sampling procedure is recommended. The advantage of establishing a sliding scale of prices based on alumina content is pointed out.

I. Introduction

The growing scarcity of the extremely high-grade diaspore clays is making it necessary to utilize lower grade materials. Also the more exacting requirements of consumers as to the alumina content of finished products demand that the manufacturer exercise more precise control over raw materials. These considerations, together with the recent development of new methods whereby the alumina content of clays can be quickly and cheaply determined, make it desirable that steps be taken toward the adoption of uniform methods and practice.

(1) Need of Standardization That there is need of some uniformity is evident by the wide variation in meaning of terms now employed. In the minds of some the term "diaspore clay" may mean a material carrying 70% or more alumina, while to others any clay carrying over 60% alumina is "diaspore." Likewise the term "burley clay" is used by some in referring to clays containing 50% or more alumina, while to others this term may mean a clay containing not less than 60% alumina. The raw basis of analysis is used by some in referring to alumina content while others use the calcined basis. Even in the manufactured products, there is no uniformity in terms used in referring to different quality materials.

More important than the question of terminology, however, is the establishment of uniform grades and methods of sampling and testing. According to present practice, clays are shipped and sold by name rather than by analysis. A purchaser may order a shipment of burley clay specifying a certain minimum alumina content. The shipper naturally attempts to grade his material as nearly as possible to this minimum specification. He is never quite sure what his clay is running and always assumes that unless there is a complaint, it is, at least, up to the minimum. If, on the other hand, a definite sampling procedure were established, whereby the

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[2] Professor of Mining Engineering, Missouri School of Mines and Metallurgy.

clay would be sampled at the pit or shipping point, the sample tested immediately by one of the short and inexpensive methods[3] recently developed, and the result wired ahead to the purchaser, the benefits would be many.

The plant manager would know the alumina content of each carload of clay before its arrival; this would permit him to separate shipments according to analyses, from which he could select any desired grade or make any desired mixture as need might arise. Thus he could utilize the clay to better advantage and make a more uniform product.

The producer would benefit by knowing immediately the quality of each shipment and could therefore exercise much better supervison of his sorting operations.

If the price of the clay varied with the alumina content, the producer could sort his clays more uniformly. Instead of mixing them to attain a minimum grade, he would try to have a uniform material regardless of its alumina content. In some cases burley clay, for example, would run 64% and in other cases 59%, according to the grade of material in the pit.

For the company producing its own clays, the matter of establishing a price based on alumina content is perhaps not so important, but the problem of sampling and analyzing and learning in advance the grade of the clay is just as important. In fact, at least one company operating its own pits has already established this practice.

(2) Present Grades and Terminology The present practice of sorting varies with different producers according to demands of customers. Some companies purchase burley clay 55 to 70% Al_2O_3, and diaspore clay 70% or more Al_2O_3; others specify second-grade burley 50 to 60% Al_2O_3, first-grade burley 60 to 70% Al_2O_3, and diaspore over 70% Al_2O_3; another specifies burley flint 45 to 55% Al_2O_3, second-grade diaspore 55 to 66% Al_2O_3, and first-grade diaspore over 66% Al_2O_3. In another instance an attempt was made to sort clays varying by only 5% in alumina content. From the above it is evident that there is no uniformity either in sorting practice or in naming the different grades.

II. Suggested Grades and Terminology

In considering this problem it is well to bear in mind the conditions under which these clays occur. The deposits are small and usually contain several different grades of clay varying in alumina content from 38 to 80%. While there is often no sharp line of demarcation between the various grades

[3] S. M. Phelps and A. C. Hughes, "A Rapid Method for the Estimation of the Alumina Content of Diaspore and High Alumina Clays," *Jour. Amer. Ceram. Soc.*, 13 [1], 1–4 (1930).

M. E. Holmes and W. D. Keller, "The Estimation of the Alumina Content of Diaspore and Burley Clays from Silica Content," presented at the Cleveland Meeting, 1931.

or layers as they occur in the pit, it is possible by carefully observing their physical properties to sort into different grades by hand selection. Just how close this sorting can be carried out at the pit is a debatable question. While it may be possible for a highly-trained workman to sort clays into grades varying by only 5% in alumina content, the writer does not believe that such sorting is practicable without unduly raising the cost of production. To sort clays varying by 5% in alumina content from 40 to 70% would necessitate sorting into 15 or more different piles, if spalls and lumps are kept separated, which is usually the case. This adds greatly to the cost, as it means that not only must all of the material be handled two or three times, but much of it must also be carried on the stock pile for months before it can be sold, with the resultant loss from shrinkage and interest on the money invested. When it is considered that the producer must also handle and throw away great quantities of waste, the total expense of mining and sorting may amount to more than the value of the clay.

It is therefore suggested that the actual grades of clay at the pit be limited to three and that they be designated and defined as follows:

(1) Burley-flint: clays containing from 45 to 55% alumina.

(2) Burley: clays containing 56 to 68% alumina.

(3) Diaspore: clays containing over 68% alumina.

This terminology is suggested because it makes use of the terms now employed in the district and with which all are familiar.

The term "flint clay" as applied to the smooth clay is generally accepted. The term "burley" was originally applied by the miners to the rough clays on account of the "burls" or "oölites" contained therein. The term is well established and would be difficult to eliminate. The word "diaspore" is restricted only to the very high-grade material. It is thought that this classification is better than using the words "second-grade burley" or "second-grade diaspore" because "second grade" implies inferiority and is more properly applied to clay containing too much iron or alkali or other impurities making it undesirable.

The grades that have been suggested may appear to vary within too wide limits. It is believed, however, that it would be impractical to sort into more than three grades. The limits as specified would ordinarily include clays as sorted by the miner. It might be possible, for example, that the producer was sorting material which he considered to be burley and which on analysis showed only 54% alumina; it should have been called "burley flint." On the other hand his burley flint might run over 55% which would put it in the burley class.

If, as before suggested, the practice of sampling and analyzing all shipments were established and prices arranged on a sliding scale according to alumina content, the producer would attempt to sort his clays by physical properties, making as uniform a product as possible and would not try

to attain any certain percentage of alumina in order to conform to a name.

It is well known that the quality of clays varies in different pits and even in the same deposit, especially on different levels. By the proposed method of sorting, the products from one pit might be burley flint 53% Al_2O_3, burley 64%, and diaspore 70%, while another pit might produce the same grades but running only 50, 59, and 68%, respectively. It is believed that such a custom would eliminate the haphazard mixing of clays and would result in the manufacturer receiving a more uniform product. If, for plant use, it is deemed necessary to increase the number of grades of clay, intermediate grades could be adopted with appropriate names.

Grades as suggested are based on the percentage of alumina in raw clay. If desired, they could be changed to the calcined basis. The shippers are more familiar with the percentages as applied to the raw materials and leasing contracts are made on this basis so that some confusion might arise from this change. It is also assumed in the discussion of grade that clays are of merchantable quality, low in iron, and free from alkalis or other deleterious substances.

III. Sampling Procedure

The previous discussion has been predicated on the assumption that each shipment of clay would be sampled and analyzed. This requires that some standardized procedure be adopted that will be fair to both producer and consumer and not too difficult or expensive to carry out.

The problem of sampling high alumina clay accurately is a difficult one. Most of the clay is in lump form and the size of lumps varies from pieces weighing a few ounces to pieces weighing 100 pounds or more. In a single piece there may be a variation of alumina content amounting to 20% or more, illustrated by a piece of burley with a little diaspore clinging to one side, while the other side might be burley flint. Unfortunately, there is no experimental data on which to base procedure. The problem, perhaps, is somewhat similar to sampling lump coal. We have the benefit of the U. S. Bureau of Mines experiments on this subject.[4] The practice as outlined in this *Bulletin* may be briefly summarized as follows:

> Gross samples of not less than 1000 pounds should be taken to give reliable results on coal that is relatively free from impurities. For coals containing a considerable portion of impurities gross samples of 1500 pounds may be necessary. . . . .
>
> Whether a delivery consists of one ton, five hundred tons, or more, the need of a gross sample weighing one thousand pounds is the same. . . . .
>
> Though a gross sample may be collected ever so carefully and may represent the coal sampled, unless it is prepared in accordance with well recognized principles, the results of analysis and test may be worthless for determining equitable settlement for the coal.

[4] "Sampling Delivered Coal," Bur. Mines, *Bull.*, No. 116.

SIZE OF COAL AND QUANTITY REQUIRED FOR EACH REDUCTION

Largest size of coal and impurities allowable in sample before division	Weight of sample to be divided in pounds
1 in.	1000 or more
3/4 in.	500
1/2 in.	250
3/8 in.	125
1/4 in.	60
3/16 in. or 4-mesh screen	30

As clay is more homogeneous than coal, it is possible that the practice as outlined, if applied to it, could be modified somewhat, and still produce satisfactory results.

The suggested sample of 1000 pounds minimum, if applied to carload lots would correspond approximately to the specifications adopted by the AMERICAN CERAMIC SOCIETY[5] for sampling ceramic materials which require that "the standard gross sample shall not be less than 1% of the total shipment."

Until other experimental data are at hand to justify some other practice, it is suggested that the specifications for sampling coal as outlined, might be applied to the sampling of clay. This would mean that a sample of about 1000 pounds should be taken from each carload.

If this sample could be taken at the plant the problem would be much simplified because crushing machinery, samplers, and conveyers could be installed that would make the work comparatively inexpensive. To be of real value, however, the sample should be taken while the car is being loaded in order that the result may be obtained before it reaches its destination. This means sampling at the pit or loading point where probably no mechanical devices would be available. The actual expense of doing this work by hand should not be over $5.00 per car or 10 to 12 cents per ton. The additional expense for analysis, if run for silica only would be from $2.00 to $2.50, making a total cost of from 15 to 18 cents per ton.

The objection to this procedure from the standpoint of the consumer is that the sample is taken by the producer and unless taken honestly, might be misrepresentative. Occasional check samples taken at the plant would soon detect any errors and the remedy is obvious.

Another method of sampling which can be accomplished at practically no expense was described by Keller[6] and is as follows:

> Carload lots are usually sampled when the car is half full and again when filled. . . . . At each operation several "cuts" of samples are taken across the width of the car. To eliminate a biased selection of the place of the "cuts" an imaginary line is taken across the car from a wall brace on one side to the brace opposite, and this line marks the po-

[5] *Jour. Amer. Ceram. Soc.*, 11 [6], 442 (1928).

[6] W. D. Keller, "A Method of Sampling Clay for Chemical Analysis," *Refrac. Jour.*, November (1930).

sition of the cut. A small chip weighing about 6 grams is broken off the highest protruding face or corner of each exposed lump lying on the line regardless of the size of the lump or character of the clay. . . . .Eight or ten chips are collected on each cut. If the car is sampled at half full and at full about 100 six-gram samples are collected. . . . . Carloads of clay that were graded against previously analyzed specimens gave analyses that checked with the standard specimens to within one or two parts in seventy. This is believed to be a reasonable degree of accuracy when the great variation of the raw material is taken into consideration.

Another method somewhat similar to the one just described has been used in the district. In this method each truckload of clay is sampled as it leaves the pit. Six small samples are taken from each load, one at each corner and one at the center of each side. Sixteen truckloads will usually fill a 45-ton car so that the car sample consists of 16 small samples, the total weight of which is about 5 pounds.

To check the accuracy of this method the following experiment was performed:

A truckload of lump burley weighing 4000 pounds was sampled by the method just described. The pit foreman took the sample which weighed about one-half pound. The entire truckload was then dumped onto a concrete floor and all the large pieces were broken down to three or four inches in size. The broken clay was thoroughly mixed and a "grab" sample weighing about forty pounds was taken. The pile was then coned and quartered to give a 1000-pound sample. This sample was reduced by hand, following the procedure outlined above for handling a 1000-pound coal sample. The results of the three samples were as follows:

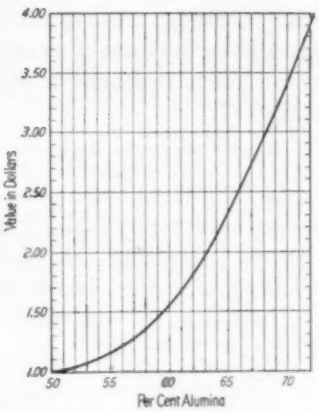

FIG. 1.—Suggested curve for determining value of clay according to alumina content. Base price of $1.00 per ton assumed for a 50% material.

1/2-lb. truck sample	63.58% Al_2O_3
40 lb. grab sample	64.73
Entire truckload	64.30

It is not contended that these results prove or disprove the accuracy of the method. They indicate that a very small sample may give fairly accurate results on clay that is well graded. Further experiments along this line would be necessary to work out the best procedure.

While the last two methods of sampling apparently give satisfactory results within reasonable limits of accuracy, the writer does not believe that they would be satisfactory as a basis for selling clays by alumina content. For companies mining their own clay, the small sample is a good check on the quality of clay in each car, but a method to be used in establishing a

price must be one that is accurate beyond question and that can be duplicated by both parties if necessary.

IV. Determination of Price from Alumina Content

If it is desirable to sample each carload of clay as herein suggested and pay for the same on the basis of alumina content, then it is necessary to establish some scale for such payments. Figure 1 shows one method of working out such a scale. It is based on the assumption that the value of a unit of alumina increases with the grade of the material. To estimate the actual price of a clay by this curve it would be necessary to establish the base price for a 50% material. This practice would be in accord with that used in many other branches of the mineral industry, where ores and concentrates are sold on the basis of analysis, and if it could be worked out satisfactorily, might prove beneficial to both producers and consumers of high alumina clays.

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A SERVICE SPALLING TEST FOR REFRACTORIES[1]

By Stuart M. Phelps,[2] S. M. Swain,[3] and R. F. Ferguson[4]

ABSTRACT

Brief comments are made on various spalling test methods and the shortcomings of these when used as suitability tests. An outline is given of the development of a service spalling test which was designed to simulate as closely as possible the conditions encountered in furnaces where spalling is important. The test differentiates between structural and thermal spalling and this is desirable because each type is caused by different conditions in service and is resisted by distinctly different properties in refractories. The data obtained in developing the test show the importance of wall thickness or the degree of insulation on the spalling of refractories in service.

I. Introduction

Some years ago the Research Advisory Committee of the American Refractories Institute made a study of specifications for refractories. This involved tests and correlation of data with service behavior. The shortcomings of spalling tests then in vogue were made evident.

The A.S.T.M. spalling test at that time was conducted at 1350°C with ends of brick immersed in 4 inches of water. Spalling test data on a variety of clay brick compared with probable service life showed clearly that this test was of little value and often quite misleading. Because of this, a study was made of several existing tests and modifications of the A.S.T.M. These were as follows:

(1) Heating the end of brick to 1350°C and immersing into 4 inches of water[5]
(2) " " " " " " " " " " 3 " " "
(3) " " " " " " " " " " 2 " " "[6]
(4) " " " " " " " " " " 1 " " "
(5) " " " " " " 850°C " " " 4 " " "
(6) " " " " " " 1600°C and cooling by means of an air blast

The data from test No. 3 were most satisfactory because of their relation to spalling in average service conditions: the loss from successive treatments was more gradual than in most of the tests and this helped to place dry-pressed brick in their right order.

The occasional loss of large pieces rather than a more gradual spalling must be expected in any test conducted upon individual brick, as such cracking is caused by rapid thermal changes in a critical temperature zone and this often occurs some distance from the heated surface. The heating and cooling of the whole end of the brick, as is the case with these tests, are

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[1] Received February 16, 1931.
[2] Senior Industrial Fellow, Refractories Fellowship, Mellon Institute.
[3] Formerly an Industrial Fellow, Refractories Fellowship, Mellon Institute.
[4] Industrial Fellow, Refractories Fellowship, Mellon Institute.
[5] A.S.T.M. Tentative Standards (1924); Serial designation C38-21T.
[6] Present A.S.T.M. Tentative Standard; Serial designation C38-27T.

quite different from the conditions in practice where all thermal changes must take place by virtue of heat transfer through one surface only.

It became obvious that in order to duplicate the conditions which cause spalling in service, a section of a wall or arch should be treated. This idea led to the design and development of the service spalling test which has proved to be an outstanding test for refractories. A report covering

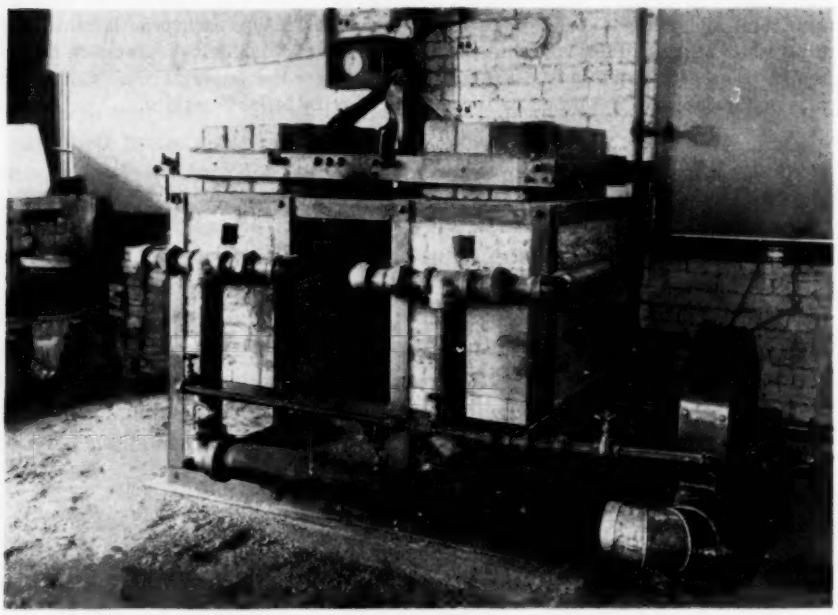

FIG. 1.—Original service spalling furnace constructed in 1924.

the early work in the development of the test appeared in Technologic Paper No. 1[7] of the American Refractories Institute.

II. Original Service Spalling Furnace

In the original test apparatus the test panels formed the arch of the furnace in the manner shown in Fig. 1. Beneath each panel there was a furnace to give the desired heat treatment. One of the furnaces was heated to a high temperature, the other at a very low temperature. At predetermined intervals the panels were transposed, thereby rapidly heating the cooler panel and cooling the hot one.

The degree of thermal shock resulting from this treatment did not produce spalling in high-grade clay brick. The surface of each panel was

[7] Stuart M. Phelps, "A Study for Refractories with Special Reference to Spalling Tests," Amer. Refractories Inst., *Tech. Paper*, No. 1, 1926.

preheated to effect appreciable vitrification of the test surface of the brick. Although indications of spalling were obtained, this test was not nearly severe enough. A special hood was installed in place of the low-temperature furnace so that air at a high velocity could be directed against the panel during cooling.

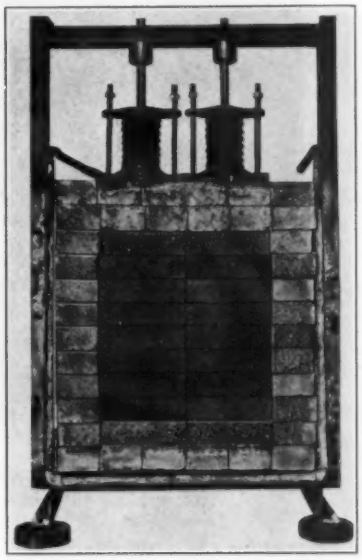

FIG. 2.—Panel and framework of improved equipment.

III. Procedure

(1) Surface Vitrification Since 1500 to 1600°C was necessary to produce sufficient surface vitrification, it was decided to preheat the panels for seven hours at 1500°C.

(2) Spalling Test The spalling test consisted of heating the surface of the panel to 1000°C and then cooling by air blast, using 10-minute intervals between reversals. After heating and cooling twelve times (twelve cycles) the panels were dismantled and loose fragments produced by spalling were removed. The index to spalling was reported as the percentage average weight loss.

This procedure proved to be satisfactory for many types of brick, but not for those which were designed for exceptional spalling resistance. Such brick were given two complete sets of treatment (preheating and 12 cycles of spalling) which not only produced an appreciable amount of spalling, but had the advantage of emphasizing the spalling characteristics of the brick.

IV. Improved Design of Test Furnace

It became necessary to increase the capacity of the furnace. It was also decided to change the general design.

(1) Test Panel The test panels in the new equipment were placed vertically to form side walls of a furnace rather than the arch. Figure 2 shows a panel, the darker brick being the test brick.

A pressure of 10 pounds per square inch is applied to the test brick. The steel frame is water cooled during preheating.

(2) Preheating Furnace The furnace shown at the left in Figs. 3 and 4 is gas-fired, downdraft. Two test panels form the opposite side walls. The panels are hung from an overhead trolley and track so that after preheating they can be moved out of the

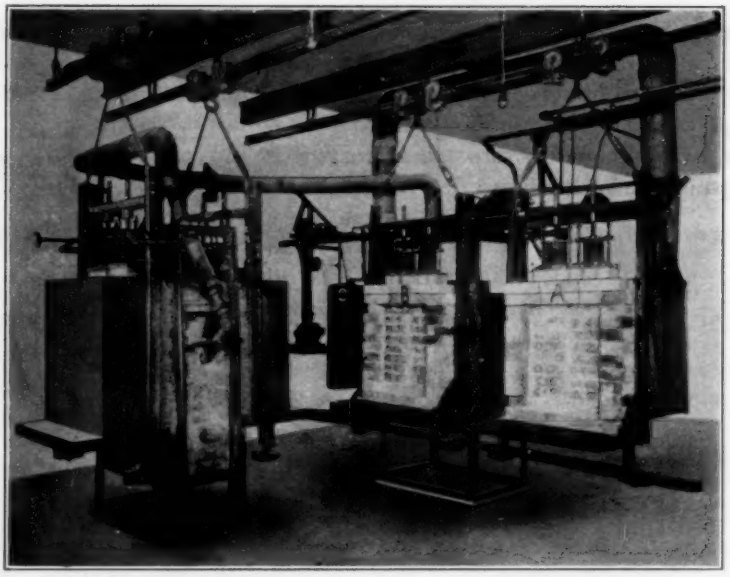

FIG. 3.—Complete service spalling equipment. Preheating furnace on the left; spalling furnace on the right with panels in position.

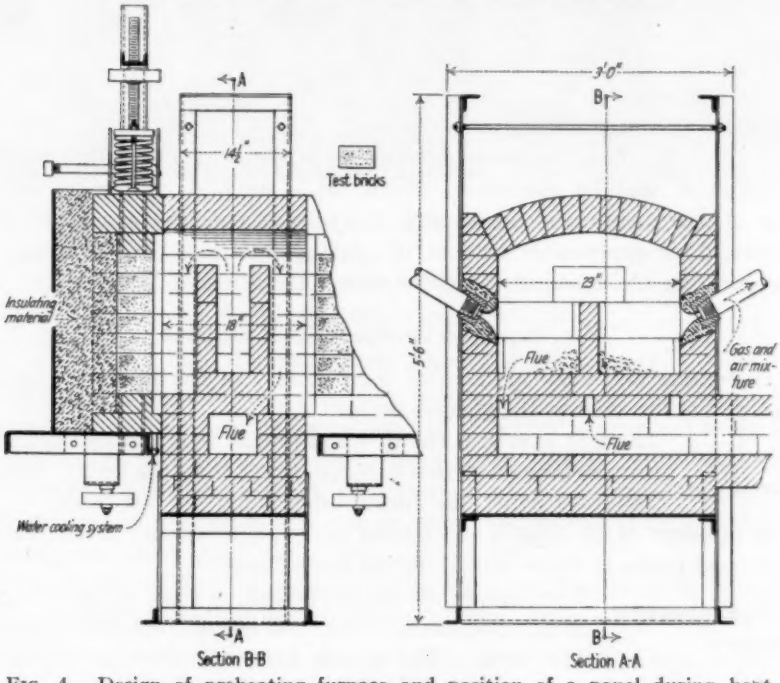

FIG. 4.—Design of preheating furnace and position of a panel during heat treatment.

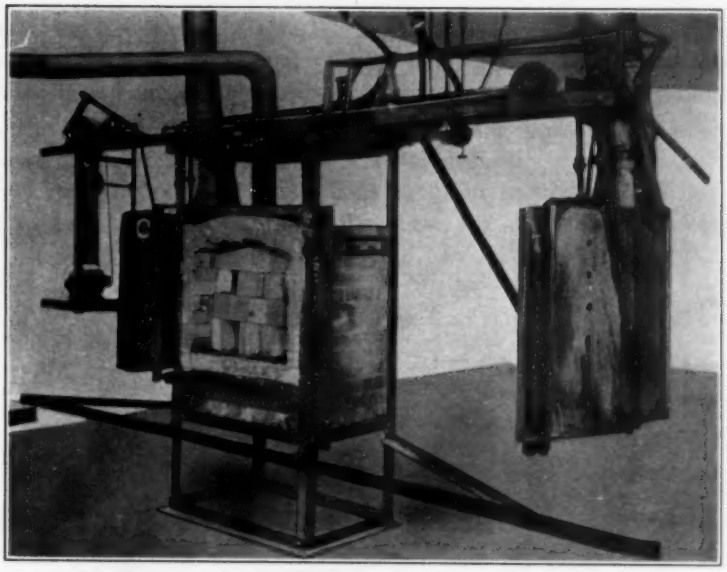

FIG. 5.—Spalling furnace with panels removed showing position of cooling units.

way or placed in position for spalling. In this manner preheating is conducted independently of the spalling test and extra panel frames allow the laying up of brick which are to be preheated at a later time.

(3) Spalling Equipment The furnace used for spalling is shown in the center of Fig. 5. While the surface of one panel is being heated, a second panel is placed in front of one of the air manifolds in the manner shown in Fig. 3. After a predetermined time the panels are moved $3^1/_2$ feet so as to place the heated panel in front of the idle cooling unit which also places the cooled panel in position for heating.

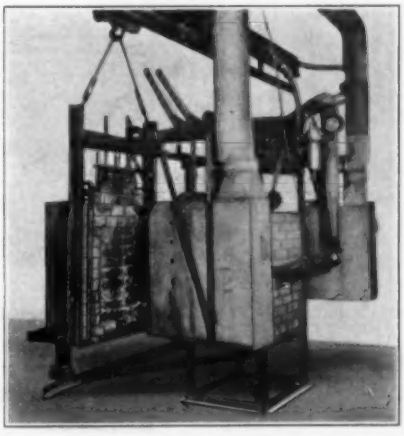

FIG. 6.—Appearance of spalling furnace from the rear showing relation of the cooling unit to the panel.

(4) Cooling Device Figure 6 shows rear view of the spalling furnace and cooling device, giving the relation of the air manifolds to the test panels. The opening in the air manifold is

$3^1/_2$ by 32 inches. An opening as small as this was found necessary to provide air at a sufficiently high velocity to rapidly cool the brick. The manifold is moved back and forth across the surface of the panel a distance

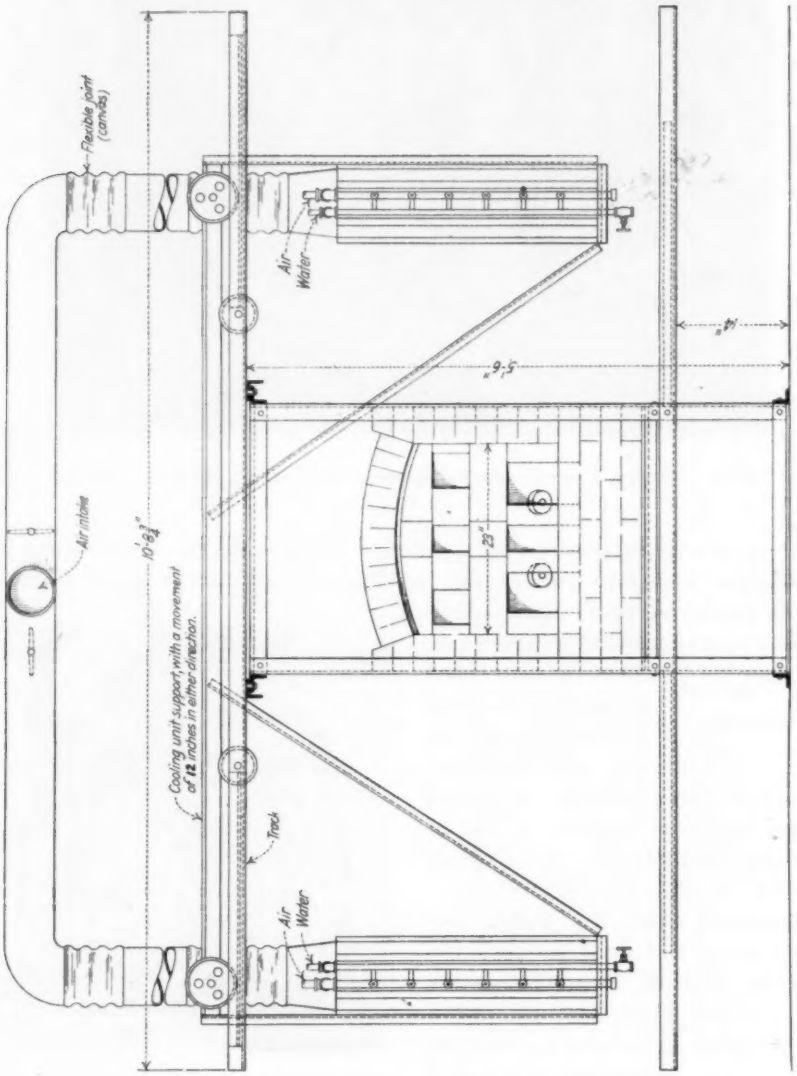

FIG. 7.—Front view of spalling furnace and cooling units.

of 24 inches to insure a uniform cooling rate. During the 10-minute cooling period the air blast passes across the panel 125 times and delivers air at the rate of 1400 cubic feet per minute. The drawings of Figures 7, 8, and 9 present the general design of the spalling equipment.

(5) Results Obtained The spalling results obtained in this apparatus were essentially the same as those supplied by the original equipment. The test could be improved, however, if sufficient spalling could be produced to allow the measurement of the loss without dismantling the panel. This would duplicate to a greater extent actual service conditions where spalling often progresses until layers of the brickwork fall away. Naturally there are objections to dismantling

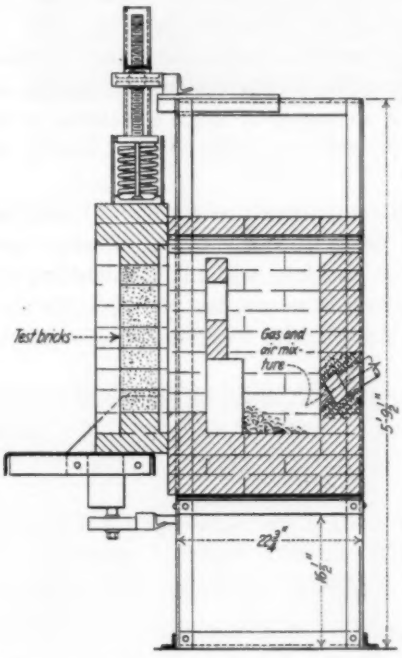

FIG. 8.—Section of spalling furnace and panel in position.

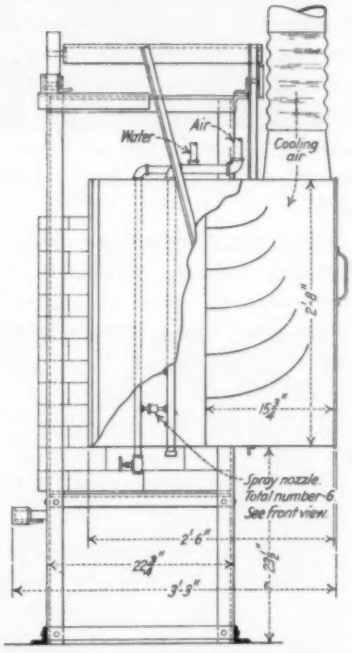

FIG. 9.—Cutaway of cooling unit showing baffles used to distribute air uniformly and water spray nozzles.

the test panels and this prompted an effort to increase still further the severity of the test.

V. Necessity of Rapid Cooling

During the spalling cycle the brick are heated at a much faster rate than they can be cooled by the air blast. Undoubtedly most of the thermal spalling occurs when the panel is placed in front of the furnace after having been cooled. If a much more rapid cooling could be produced the amount of spalling should increase accordingly.

The blower used was driven by a 3 h.p., 3400 r.p.m. motor and to

increase the amount of cooling to the point where the desired spalling would take place would mean a motor blower unit of an impractical size. The specific heat of air is very low and this makes it an inefficient cooling medium. Water-saturated air was tried which increased the rate of cooling, but much greater effects were obtained by introducing a very fine mist of water into the air blast. This proved so successful that a battery of six high-pressure sprays were installed in each cooling unit as may be seen in Figs. 7 and 9. These sprays are operated by compressed air at 30 pounds and the water used is filtered and fed through brass pipes, because of the small orifice of the spray necessary to produce the mist.

The sprays are regulated to be uniform from top to bottom and to deliver water at the rate of $2^1/_2$ gallons per cycle. This quantity of water applied as a mist in the air blast is not sufficient to cause a wetting of the surface of the brick during testing, but is very effective in cooling the brick.

The amount of spalling produced by this procedure is several times that obtained with the air blast alone. With it many types of brick spall sufficiently to allow measurement of the loss without dismantling the panel. Brick designed to resist spalling, however, are not likely to show sufficient loss and for this reason, it has become a regular practice to dismantle all panels.

Most of the spalling caused by the thermal shock of the partially vitrified surface of the test brick occurs as a conchoidal fracture. This causes an interlocking of the fragments which are not loosened until the brick are separated.

No difficulty is experienced in dismantling the panel when a high-grade kaolin is used to lay up the brick. The adhering kaolin is removed before weighing and in doing this all loose fragments caused by spalling fall off.

(A) Increase Temperature of Preheating

At this period in the development of the test, a large number of commercial brick of unusual spalling resistance were tested. The temperature of preheating was raised to 1600°C and the time period was lengthened to 24 hours. This treatment with the subsequent spalling by the air-moisture blast gave an index to the spalling behavior of most of the brick tested.

On a number of occasions a series of commercial brick were tested and at the same time additional brick of the same brands were placed in service where spalling was severe. In almost every instance the spalling order was the same in the test as in commercial furnaces.

VI. Nature of the Results Obtained

Studies conducted in recent years on the cause and nature of spalling

in service have established two distinct types of spalling,[8] the cause of each being of an entirely different nature. These are termed "structural" and "thermal" spalling. Heretofore spalling tests have been of the type which attempt to evaluate only the thermal spalling, while in actual service very

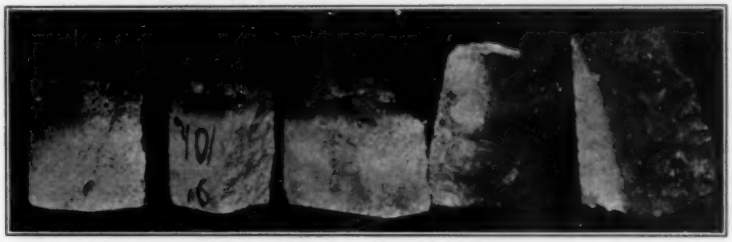

FIG. 10.—Bung brick taken from service after 5, 10, 20, 26, and 37 heats. Note progress of structural spalling.

few clay brick can be thermally spalled unless structural changes have taken place. R. M. Howe (see bibliography) recommended the preheating of test brick before water-dip spalling for the purpose of introducing structural changes, but this

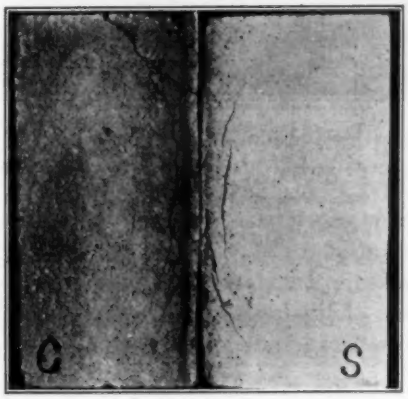

FIG. 11.—Typical structural spalling obtained in preheating test.

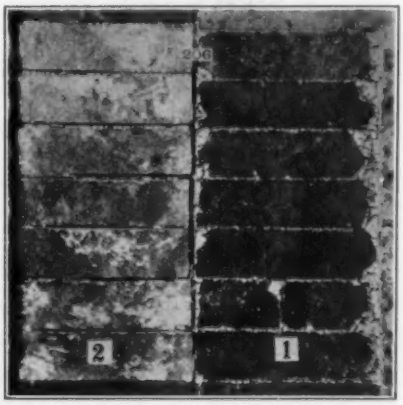

FIG. 12.—Two brands of brick after preheating. No. 1 shows shrinkage crack, while No. 2 shrank badly, but without cracks, which accounts for the large joint openings.

practice has the disadvantage of changing the structure of the whole brick in place of only that region which is exposed to heat.

(1) Structural Spalling

Undoubtedly, in clay refractories, structural spalling is equally as important as thermal spalling. Refractories used in the bungs of malleable furnaces are a good

[8] See A.S.T.M. tentative definition for spalling C71-27T.

example because they are subjected to heat treatment which causes structural changes as well as severe thermal shock. Thermal changes without the accompanying high temperature treatment of the bungs in position could not account for the behavior of these brick in service.

The effect of high temperatures for varying periods of time will range from a partial vitrification to the formation of a deep layer of a glassy structure. In many kinds of clay brick this change causes shrinkage which often progresses to the degree evident in Fig. 10. These samples were taken from a bung at intervals during the life of the brick and show the nature of structural spalling in service. Another example of this is given in Fig. 11 which shows two brick after the preheating operation of the service spalling test.

If the nature of the clays or the structure of the brick is such that com-

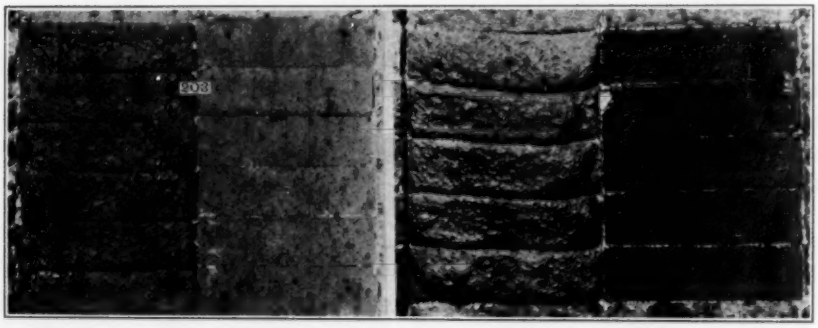

FIG. 13.—Effects produced by preheating comparative lots of brick.

mercial heat treatment will cause shrinkage, this will result in the separation of layers, the formation of deep cracks, or the reduction in size of the heated portion without crack formation. The last two conditions are illustrated in Fig. 12 showing two lots of brick after preheating. Brick No. 2 have shrunk so badly as to cause large joint openings, while No. 1 show shrinkage cracks.

The preheating during the service spalling test is aimed to simulate service in producing such structural changes. The examination of test brick after preheating and before spalling along with the photographic record gives an excellent insight as to the probable behavior of the brick in service. This part of the test is also valuable as a "refractoriness" test in comparing various lots of brick as is indicated in Fig. 13.

In many furnace operations the presence of volatile fluxes and slags increases the severity of the structural changes or produces them at a lower temperature. Some experiments have been conducted using slag-

coated panels during preheating with interesting results, but to date this procedure has not become a regular practice.

(2) Thermal Spalling The properties of a refractory effecting thermal spalling are reversible thermal expansion, elasticity, heat transfer, plastic flow, and strength. All of these properties are affected to a degree by the temperature and duration in service combined

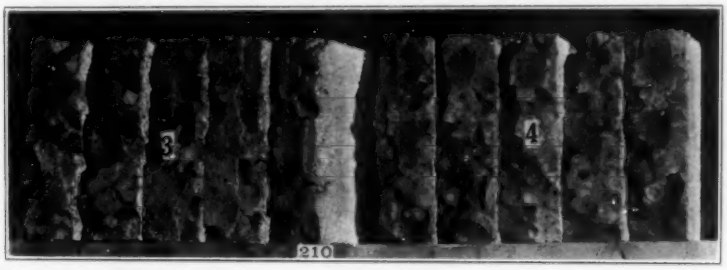

FIG. 14.—Typical spalling of preheated brick. Note loss in vitrified region.

with the action of slags, fluxes, and to no small degree by the furnace atmosphere. Furthermore, since refractories are usually heat-treated through one face, the degree of heat insulation on the opposite side will determine the depth to which the above-mentioned properties will be altered.

The extent to which the individual characteristics are changed in service can be measured by precise laboratory methods, but their final effect on thermal spalling is best brought out in the spalling of preheated panels. The cracking or separation of fragments from thermal shock usually occurs in the area which has been affected by heat treatment as shown in Fig. 14. The fact that a marked change has been produced by preheating does not always mean that a sensitivity to temperature change will result, an example of which is given in Fig. 15. Some types of brick become sensitive to these changes in the zone between the altered portion and that unaffected by heat.

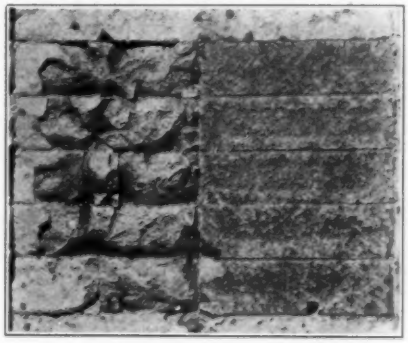

FIG. 15.—Panel after spalling showing a marked loss in one lot of brick and good resistance in the other brand.

The behavior in the service spalling test of various types of brick from different producing districts may be seen in Table I. For the purpose of

TABLE I

BEHAVIOR OF HIGH-HEAT DUTY BRICK IN THE WATER DIP AND SERVICE SPALLING TESTS

Brand	Process of manufacture	District of manufacture	P.C.E.	No. of dips in A.S.T.M. water spalling for failure (20% loss)	Av. loss of 7 brick in 1 treatment of service spalling test (%)
1	Dry-press	Missouri	32–33	13	18
2	" "	"	33	22	7
3	" "	"	33	25	0
4	" "	"	33	71	0
5	" "	Kentucky	31–32	21	15
6	" "	"	32–33	15	17
7	" "	Pacific Coast	31	13	6
8	Hand-made	Pennsylvania	32–33	36	16
9	" "	"	32	35	2
10	" "	Maryland	33	43	0
11	Stiff-mud	Pacific Coast	31–32	15	0
12	" "	Missouri	30–31	10	22
13	" "	Kentucky	30–31	14	15
14	" "	Ohio	30–31	10	28
15	" "	Pacific Coast	30	10	19
16	Soft-mud	New Jersey	28–29	6	1
17	" "	New York	28	11	17

comparison there is also given the results obtained in the water-dip spalling test. These figures show that there is no relation between the two tests.

VII. Effect of Insulation on Spalling

As previously mentioned the depth to which structural changes occur in service is dependent to a large degree upon the effectiveness of the insulation. This also will govern the amount of spalling in many instances.

TABLE II

SPALLING LOSS CAUSED BY EFFECT OF INSULATION, TEMPERATURE OF PREHEATING, AND TEMPERATURE OF SPALLING

(Average loss of seven brick in one treatment)

Brand	P.C.E.	Temperature of preheating for 24 hours (°C)	Insulation during preheating	Spalling loss for 12 cycles: Temp. of spalling (1000°C)	Spalling loss for 12 cycles: Temp. of spalling (600°C)
	32–33	1600	Insulated	16%	10%
			Uninsulated	3	0
(A) Pa. hand-made	32–33	1500	Insulated	8	
			Uninsulated	1	
	30–31	1600	Insulated	28	19
			Uninsulated	9	0
(B) Ohio stiff-mud	30–31	1500	Insulated	19	
			Uninsulated	5	
(C) Missouri dry-pressed	32–33	1600	Insulated	18	
			Uninsulated	7	
(D) Missouri dry-pressed	33	1600	Insulated	0	
			Uninsulated	0	
(E) Missouri dry-pressed	32–33	1600	Insulated	4	
			Uninsulated	2	
(F) Pa. dry-pressed	32–33	1600	Insulated	17	
			Uninsulated	3	
(G) Pa. hand-made	31–32	1600	Insulated	13	
			Uninsulated	1	

To study this factor in the test method, panels were preheated, with and without insulation. A sheet metal shell was placed 8 inches away from the cool side of the test brick and the intervening space was filled with a calcined diatomaceous earth. The temperature gradient within the test brick during preheating is given in Fig. 16. The high temperature throughout the brick in the insulated panel produced structural changes to a depth which is several times that obtained without insulation. As would be

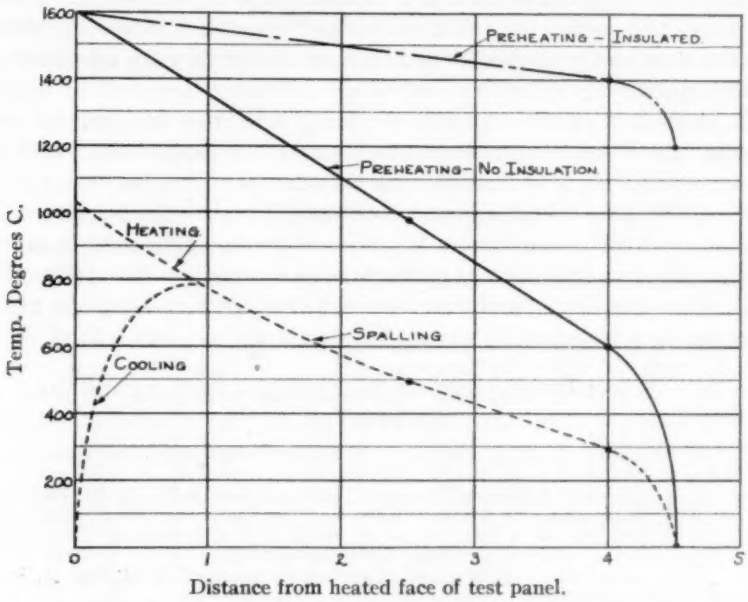

FIG. 16.—Chart giving temperature gradient within the test brick in a panel during preheating when insulated and uninsulated. The dotted line shows the maximum temperature of the brick during heating and the minimum temperature during cooling in the spalling cycle.

expected the spalling loss for panels so treated was of the same order as may be seen from the data in Table II. These data also give the results of two temperatures of preheating and spalling as obtained on two brands.

This demonstrates that insulation may increase the amount of spalling several times. The effect of insulation on spalling in service will vary, depending upon how close the furnace temperature may be to the critical range of the refractory. This fact has been learned through experience by many furnace men and in most cases it is resolved into a balance between heat loss and the cost of fire brick.

VIII. Recommendation for Test Procedure

The service spalling test has been in the process of development for six

years, during which time a great many brick representing all types of refractories have been tested. The data obtained have been of considerable value to manufacturers in developmental work and to consumers in selecting suitable brick. With a modified procedure silica, chrome, and magnesite can be tested as successfully as clay brick.

As a result of the experiments conducted in the equipment as developed to date, the following procedure is recommended: The test panels are preheated for 24 hours in front of a furnace operating at 1600°C. During the preheating period the brick are backed up with 8 inches of calcined diatomaceous earth. After the panels have cooled they are examined and photographed.

The preheated panel is spalled by placing it in front of a furnace operating at 1450°C for 10 minutes producing a surface temperature of 1000°C and then removing it to be cooled for the same period by air-water (mist) blast. After twelve heatings and coolings (12 cycles) the panels are dismantled and all excess kaolin is removed by scraping with a trowel. The average loss in weight in percentage is reported as the spalling loss.

Provided the above treatment does not produce a spalling loss of 5%, the complete test should be repeated a second and possibly a third time.

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EXPERIENCE WITH OPEN SETTING OF GLOST WALL TILE IN TUNNEL KILNS[1]

By Gordon Klein

ABSTRACT

New types of setters for holding tile during firing are described. The savings effected by their use instead of saggers in three plants are given. Other advantages such as possible faster heating and cooling cycles are explained.

I. Introduction

During the past two and one-half years the writer has been actively engaged in the development of tile setters for the purpose of securing a more efficient ware support than the saggers commonly used in firing glost tile. The experience in this work should be of interest and value to the industry. The history of the development to date, as typified by major experience in three tile plants is presented, as well as an idea of what the results obtained promise for future use of this method.

The need of improvement over the old sagger is easily recognized. The objectives to be accomplished by proper design of setters are:

(1) Conservation of kiln space permitting smaller kilns at less cost per given capacity and making possible increased capacity for existing kilns. For example, in one instance, the number of square feet of tile that could be loaded on a tunnel kiln car was increased from 480 to 910 square feet.

(2) Reduction of sagger costs by eliminating inherent faults in saggers by reason of their design. If the design was such as to make it hold more tile, the cost per square foot of tile would be reduced. This expectation was realized. One plant showed a cost of three and one-half mills per square foot of good tile produced over a period of five months. Improvements in design and manufacture have further decreased this cost.

(3) A reduction in fuel cost per square foot of tile was expected. It was found that in a kiln firing 12,000 square feet per day in saggers, the total weight in saggers and tile was 175,000 pounds and the fuel consumption was 150,000 cubic feet of natural gas. With setters, 23,000 square feet of tile could be placed on the cars having a total weight of 169,000 pounds and the fuel consumption would be the same or somewhat less.

Further benefits have become evident in plant use. These advantages, partly unforeseen and partly secured by improvement in design, will be described fully later. The experience with these setters in three different plants, which will be referred to as plants A, B, and C, is described as follows.

Plant A manufactures wall tile, firing a muffle kiln 150 feet long with oil as the fuel.

Plant B manufactures wall tile, firing in a direct-fired kiln 330 feet long

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Received January 21, 1931.

with natural gas as the fuel. The kiln is also equipped with an auxiliary oil system.

Plant C manufactures wall tile, firing in a direct-fired kiln 322 feet long with natural gas as the fuel.

II. Discussion of Development and Results in Plant A

Type of kiln	Muffle
Firing temperature	Cone 01
Fuel	Oil
Capacity	6500 sq. ft. per day with setters

Figure 1 shows the original 6- by 3-pintype setter. It was made in four pieces with the top and bottom interchangeable, was shipped knocked down, and assembled on the job. It was $11^3/_4$ inches long, $6^1/_2$ inches deep, and $12^1/_2$ inches high, designed to hold thirty-three 6- by 3-tile.

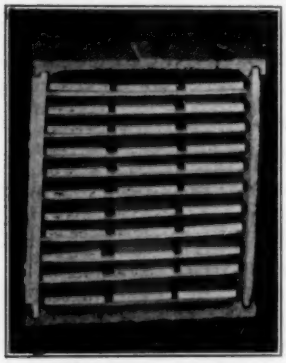

FIG. 1.—4-piece 6- by 3-setter.

Figure 2 shows the original $4^1/_4$-pintype double setter. It was also made in four pieces and was $11^3/_4$ inches long, $9^1/_4$ inches deep, and $12^1/_2$ inches high, designed to hold forty-four $4^1/_4$-inch tile. A variation of this setter was a single $4^1/_4$-setter of the same dimensions, except that it was $4^5/_8$ inches deep, and held twenty-two $4^1/_4$-inch tile.

When the setters were received on the job they were erected and cemented at the corners. A man could assemble about eight setters of either size per hour. After drying for an hour, the setters were handled without danger of coming apart.

The loading space on the tunnel kiln car was 42 inches wide and 72 inches long; setting height, approximately 42 inches.

Figure 3 shows a loaded car. One hundred and eight 6- by 3-pintype setters, placed three high, made up a load. This gave a capacity of 445 square feet of tile per car. Seventy-two $4^1/_4$-pintype double setters were also loaded on one car, giving a capacity of 510 square feet per car. The setters were so designed that both $4^1/_4$- and 6- by 3-setters were placed on the same car if desired.

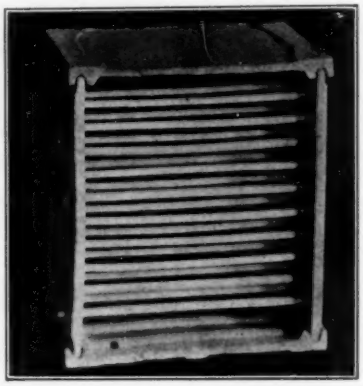

FIG. 2.—4-piece $4^1/_4$-double setter.

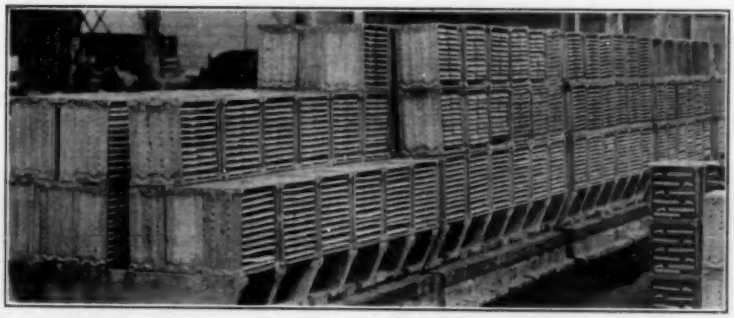

FIG. 3.—Loaded car, plant A.

The life of this type of setter was 65 trips, which gave a cost of $3^1/_2$ mills per square foot of tile. This cost was arrived at by taking an inventory at the beginning of the period and charging the setter account with all additions and labor during the 5-month period. The inventory at the end of this period was taken and subtracted from the total in the account. The resultant figure was divided by the number of square feet of good tile produced and the cost arrived at was $3^1/_2$ mills per square foot.

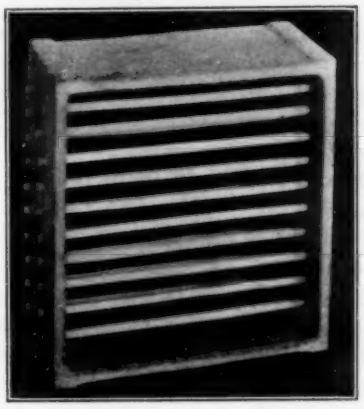

FIG. 4.—1-piece 6- by 3-pintype setter.

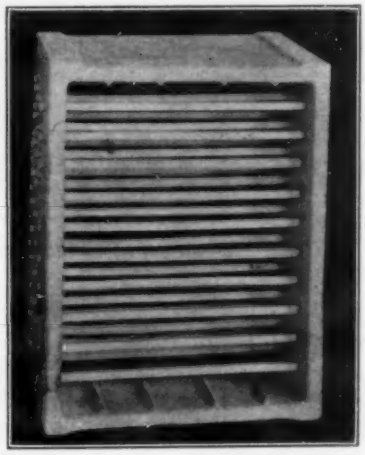

FIG. 5.—1-piece, double $4^1/_4$-setter, pin type.

Figure 4 shows a one-piece, 6- by 3-pintype setter which replaced the four-piece setter. The double $4^1/_4$-setter was also made in one piece, as shown in Fig. 5. The dimensions and capacities of these setters were the same as the four-piece setters. Longer life with the one-piece setter was anticipated and secured, besides effecting a saving of the labor used in

assembling four-piece setters. The one-piece setter also has greater mechanical strength than the four-piece setter.

The next step in this development was the lugtype setter, Figs. 6 and 7. The lug setter eliminates all possibilities of pin dirt and pin marking. Ob-

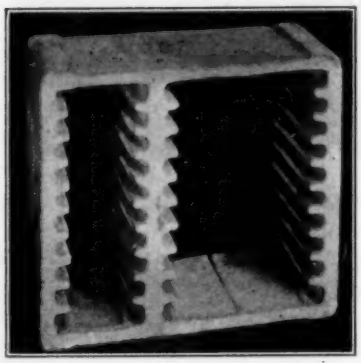

FIG. 6.—6- by 3-lug type.

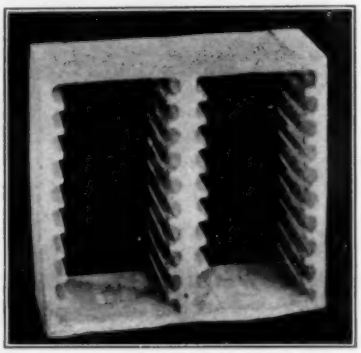

FIG. 7.—$4^1/_4$-lug type, single.

viously, it also eliminates all pin expense and has increased the capacity per unit of setting volume about 10%.

Results secured from a firing standpoint, with all setters, were excellent. All glazes were properly matured. No trouble was experienced from scumming and the percentage of dirty tile was well within practical limits in all types of setters.

III. Discussion of Development and Results in Plant B

Type of kiln	Direct fire
Firing temperature	Cone 9
Fuel	Natural gas with auxiliary oil system
Capacity	12,000 sq. ft. per day with saggers

The loading space on the cars was 58 inches wide by 78 inches long; setting height, approximately 60 inches. The setters were cast one-piece pin-type of two sizes: (1) $13^1/_2$ inches wide by $13^3/_4$ inches high by $9^7/_8$ inches deep and (2) $13^1/_2$ inches wide by $15^1/_4$ inches high by $9^7/_8$ inches deep, outside dimensions; all walls were $^5/_8$ inch thick. The largest setter held eighty-four pieces of tile, either $4^1/_4$ or 6 by 3, and the smaller, six pieces less. There were six rows of pins across the setter. To be brief, the setters may be described as double 6- by 3- or triple $4^1/_4$-setters. Placing 6- by 3-tile offered no difficulties, but placing the inner or center row of $4^1/_4$-tile was slow.

Eighty-seven setters of either size were loaded on a car. This gave a capacity of 913 square feet of tile per car with setters, against 480 square feet with saggers, an increase of nearly 90% per car. The life of these

setters was nearly thirty trips, or at least four times that of the saggers in use. Experience has proved that a smaller setter would, undoubtedly, last many trips longer, but the user, realizing that the larger the unit, the greater the economy of kiln volume, wanted the larger size.

There was a little trouble from dirt, but by careful attention to all sources it was possible to fire clean tile.

Due to the high firing temperature, cone 9, there was trouble with sagging pins. Bent pins make both loading and unloading difficult, aside from the fact that they may mark a colored enamel and are a pregnant source of dirt.

The lugtype setters shown in Figs. 8 and 9, are now being made for use in this plant. They may be described as a double $4^1/_4$- and a single 6- by 6-lug type; the 6- by 6-setter being adapted for use with either 6- by 3- or 6- by 6-tile.

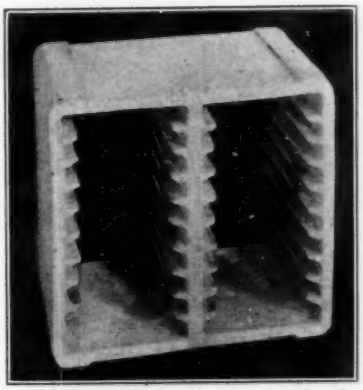

FIG. 8.—$4^1/_4$-double lug type.

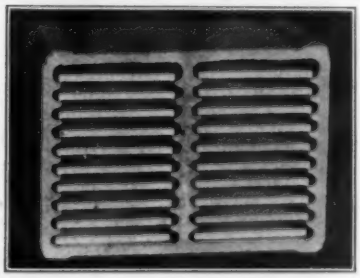

FIG. 9.—6- by 3- or 6- by 6-lug type.

At the time this work was done, the loading with saggers was such that one car had a capacity of 480 square feet of tile. On a fifty-five minute schedule, 26 cars were put through for a total of 12,500 square feet per day in 3000 saggers. A loaded sagger holding $4^1/_4$ square feet of tile weighed 58 pounds, giving a total weight of 174,000 pounds of saggers, pins, and tile, fired per twenty-four hours. In comparison, 913 square feet of tile per car could be loaded with setters. Twenty-six cars per day would then give a capacity of 23,700 square feet in 2262 setters. A loaded setter weighs 75 pounds, giving a total weight of 169,000 pounds per day of setters, pins, and tile. The fuel consumption ran 150,000 cubic feet of natural gas per twenty-four hours. With saggers, it was used to fire 12,500 square feet of tile; with setters, it might have easily fired 23,700 square feet of tile. These figures show that the open setter unquestionably offers a source of fuel saving.

The results secured from a firing standpoint were satisfactory. Of

course, with the direct-fired kiln, one has to use care in placing the setters to guard against flashing. The closed side of the setter should be placed to face the burners.

IV. Discussion of Development and Results in Plant C

Type of kiln	Direct fired
Firing temperature	Cone 4
Fuel	Natural gas
Capacity	20 cars daily

Setters used originally were cast one-piece pin type, $10^1/_2$ inches wide by $13^7/_8$ inches high by $10^1/_2$ inches deep, holding forty-four $4^1/_4$-tile (Fig. 5). Later, a 6- by 3-cast one-piece pintype setter, $11^1/_2$ inches wide by $13^7/_8$ inches high and $6^5/_8$ inches deep, holding thirty 6- by 3-tile, similar to that in Fig. 4, was used.

Advantages in placing capacity of setters over saggers, per volume of

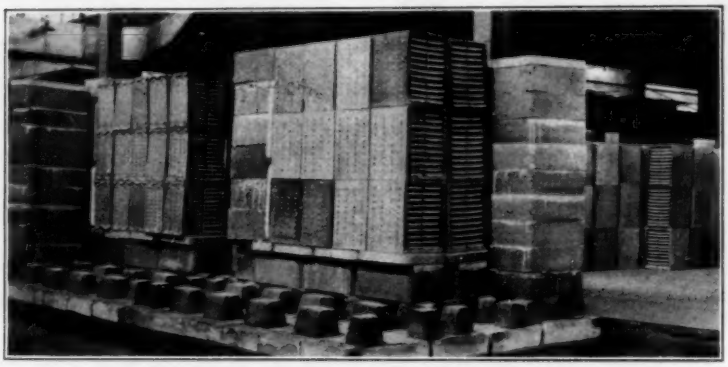

FIG. 10.—Loaded car in plant C.

kiln space, are relatively the same in this plant as in plant B. There is, however, one radical difference in that, with the exception of blacks and a few other hardy colors, some difficulty is experienced in open setting. In order to get satisfactory results, the setters have to be placed so that the flame from the burners does not impinge upon the tile. This is accomplished by placing the closed side of the setter toward the fire box, with a row of saggers along the edge of the cars, adjacent to the side walls of the kiln, as shown in Fig. 10, a makeshift plan, but conclusive proof that the plant operators recognize the advantages of the setters. Some trouble was experienced from the pins shelling off after eight or ten trips, but a pin has finally been developed that seems immune to this trouble. A number of the lug setters and a setter with a removable back have been supplied so that setters may now be placed over the entire car. Figure 10 shows the present loading arrangement of the car.

The records at this plant show a saving of five to six cents per square foot of tile through the use of the setter.

V. Discussion of Various Types of Setters

Various types of setters may be divided as follows: (1) pin type, four-piece, Figs. 1 and 2; (2) pin type, one-piece, Figs. 4 and 5; (3) lug type, Figs. 6, 7, 8, and 9; (4) shelf type: (*a*) integral shelf, Fig. 11; (*b*) removable shelf, Fig. 12.

The pintype four-piece setter, although still used in quantities, gives trouble through a gradual breaking down and weakening of the cement in the joints. The setter becomes loose gradually and gets out of plumb. In addition to this, it is mechanically weak since the light lugs on the ends of

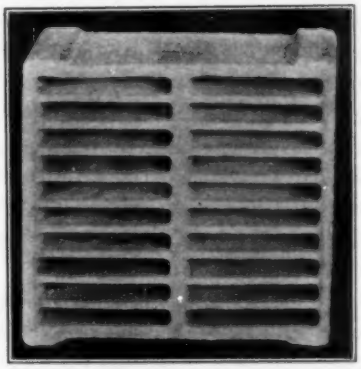

FIG. 11.—Integral shelf.

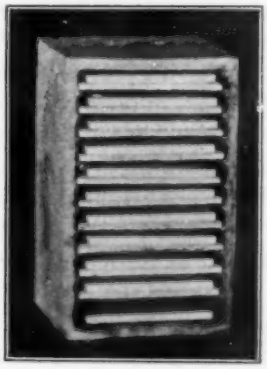

FIG. 12.—Removable shelf.

the top and bottom pieces snap off easily. There is also the not inconsiderable item of expense in erection and the losses experienced in shipping and handling from breakage. Most of these difficulties have been eliminated by the one-piece setter of the same type, which is considered the last word in the pintype setter.

The one-piece pintype setter has been made in a variety of sizes having capacities of from $4^1/_8$ square feet to $10^1/_2$ square feet of tile. As mentioned before, experience has proved that the smaller units give the greatest number of trips, but that the larger setters are the most economical from the standpoint of kiln volume. The one-piece pintype setter, however, still includes that item of expense, pins, which includes not only the first cost of pins but the expensive replacements, in addition to the labor involved. Pins sometimes sag and where they come close to a susceptible glaze, tile will often be marked. In other cases they shell off after they have been in use for a number of trips causing dirty tile.

The marking of tile can, of course, be eliminated somewhat by putting the pins on greater centers, but this is a makeshift that is putting off the day of trouble if the pin has a tendency to sag. Obviously, a pin that does not sag will eliminate this difficulty and in some cases no trouble of this kind has been experienced.

The pin setter has, however, one very good feature and that is its flexibility. By removing one or more rows of pins, trim and shapes of all description may be placed without an unreasonable loss in capacity. At some sacrifice, of course, $4^1/_4$-tile may be placed in a 6- by 3-setter.

The greatest advantage of the lugtype setter is derived through the elimination of pins. As mentioned before, the first cost of pins and the labor of maintaining the setter in a workable condition by replacing broken and warped pins is a considerable item of expense. Properly made, the lug setter is easier to load and unload than the pin setter, since very little care has to be exercised, whereas with the pin type, some care must be taken not to break the pins or shake them out of position. The lug setter offers an advantage of nearly 10% of placing volume over pin setters of the same dimensions. This is brought about through the closer spacing of tile permissible on lugs. The lugs or ribs also strengthen the setter, as compared with any weakness which might occur from the holes in the pin type. It is not, however, as flexible a setter as the pin type. Shapes can be placed, but at considerable sacrifice of setting volume.

Of the shelf-type setter, there are two types, the integral and the removable. These setters both offer a perfect support for the entire tile. It is considered particularly adapted to the manufacture of vitreous tile, which are liable to warp at maturity. It should also help to eliminate trouble with chipping, warping, and so forth, encountered when one-fired tile is attempted in rearing. There is no doubt but that it is a more efficient arrangement than the individual or multiple crank because it is just one unit to handle for a score or more of tile, as compared to one, two, or three pieces of tile per crank. The integral type is more rugged and strong than the removable-shelf type.

It is difficult to determine how much economy is effected through setters, as compared with saggers, but an idea may be obtained by a comparison of the various plant operations affected.

As related earlier in the description of the work at plant B, the same tunnel kiln car loaded with setters, as compared to saggers, showed an actual increase of capacity around 90%. This same ratio holds in estimating the floor space and skid capacity required for storage of empty and filled setters. The weight and bulk of setters required per day per glaze machine would be about one-half that required with saggers. This will simplify the foreman's daily struggle of having a sufficient placing capacity at hand to keep the glaze machine operating smoothly. There is no doubt

but that the shop will look neater and more orderly than with saggers, all of which is conducive to better operation and products.

Because of their lightness, there is no practical reason why a woman cannot place an empty setter at the glaze machine. In fact, this is often done, allowing the operator, a man, more time to perform other odd jobs around the machine.

In placing the tile, there is very little difference of time in rearing the saggers, against flat placing in setters. But in those cases where flat placing in saggers is necessary and where a false support has to be built up in the sagger with bats and blocks, there is an enormous saving in both time and kiln volume. One of the largest sources of loss in flat placing in saggers is from sagger dirt. This loss is not experienced with the setter which is, of course, an item of considerable interest to the manufacturer.

After the tile is placed in the setter the next operation is to convey them to the loading dock of the tunnel kiln. In most cases, fewer units are handled when setters are used, as compared to saggers, but this is not the rule, as the setter size depends entirely upon the dimensions of the tunnel kiln car and the wishes of the user. In some cases setters have been furnished holding thirty-three 6- by 3-tile, which is about the capacity of a regular tile sagger using reared placing. Here the number of units handled, of course, is about the same, but again in plant B, a setter holding eighty-four 6- by 3-tile was used; the number of setters handled was about one-third that of the saggers.

To date there has not been a tunnel kiln wreck with the setter. The new user is ordinarily a little apprehensive when he gazes upon the $^1/_2$- or $^5/_8$-inch walls, but the strength is there and the subsequent behavior of the setter in practice soon relieves his mind along this line.

There does not appear to be any particular advantage with setters over saggers as to heat distribution on the car during firing. If the tunnel kiln is under-firing the bottom end centers of the cars, the tile setters will not eliminate this defect in kiln design. The setters are, of course, more rapid in getting the heat to the glaze than are saggers. This is due both to the thin walls and the direct exposure of the glaze to the hot air and gases. Tile fired in saggers is matured principally by heat transferred through the heavy sagger walls and not by heat taken directly from the gases in the case of open fire. The efficiency of these two methods of heat transference is obvious. The open setter offers another advantage in firing, since a car loaded with setters cools and heats much more readily than a car loaded with saggers. This is important since it makes possible an increase of kiln schedule. It is of particular importance where production is being pushed and there is a shortage of cars at the exit end of the kiln.

In unloading the setters, in the case of the pin type, it was found inadvisable to dump the setter. In the use of the lug type, this method of

unloading is entirely practical since there is no danger of breaking or displacing pins which have been eliminated in the lug setter. In the case of saggers most plants have to reset or repin all saggers after emptying. In one large plant there are about ten men employed continuously in this operation. The lugtype setter eliminates this expense. In the case of the pin setter, there is some item of expense in replacing the broken and warped pins, but, on the whole, nothing that one man could not take care of for a normal production of 10,000 square feet per day.

While there is no question but that the open setter can be used in the direct-fired kiln to a greater or less degree, it is equally definite that the muffle type kiln is better adapted.

In plant C, which has a direct-fired kiln, it was not possible to use the open setters except in the center of the car, protected by saggers.

In plant B, where a glaze approaching the porcelain type was used, the more extensive use of the setter in the direct-fired kiln was possible than in plant C, where more volatile glazes were in use.

In plant A, where a very susceptible glaze was used, the open setter could be used 100% with satisfactory results.

The results of the work done in this development show conclusively: (1) that kiln space can be conserved, (2) that sagger costs can be greatly reduced, (3) that fuel costs can be greatly reduced, and (4) that economies in other parts of the factory than the firing operation are secured, so that the total benefits are much greater than the benefits derived from the firing operation itself.

New Castle Refractories Co.
New Castle, Pa.

GRANULAR AND GROUND FELDSPAR WITH A UNIFORMLY LOW IRON CONTENT[1]

By J. H. Weis

ABSTRACT

The feldspar industry has long sought a mechanical process to replace the inefficient hand sorting of feldspar. A dry mechanical process was developed for removing iron-bearing impurities from feldspar by means of Rowand-Wetherill magnetic separators. These separators were replaced with newly-developed, more efficient induction magnetic separators which produced results never before attained in the industry. Granular feldspar was developed for the glass industry in conjunction with the new process of feldspar preparation. Feldspar with a uniformly low iron content and free from the usual iron-bearing minerals can now be produced from run-of-mine or hand-selected feldspar.

I. Introduction

There are two types of impurities in run-of-mine feldspar. The most important types of impurities which must be entirely separated from the feldspar are the iron-bearing minerals. Since the presence in feldspar of a fraction of 1% of such iron-bearing minerals as biotite mica, garnet, or tourmaline, would render useless such a product, it is apparent that great care must be exercised in the hand selection of run-of-mine feldspar.

Quartz is an impurity, not as harmful as iron minerals, since it adds only to the silica content reducing proportionately the other components of the feldspar. The average feldspar consumed contains approximately 15% free quartz.

Kaolin is an impurity in some southern feldspars. It is usually separated out by washing or by careful hand selection.

Under existing processes, feldspar is hand selected after mining, and only the large pieces apparently free from impurities are selected from the run-of-mine material. This method is costly because of the large amount of waste, usually over 75%, resulting in high mining costs. It also causes early depletion of the richer feldspar deposits. Furthermore, complete removal by hand selection of all iron-bearing minerals from most feldspars is not practical.

II. Rowand-Wetherill Magnetic Separation

In 1927, a feldspar mill possessing an immense single pegmatite dike whose impurities could not be separated by hand selection because of the small size of the feldspar crystals, experimented with available concentrat-

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Received December 26, 1930; revised copy received January 15, 1931.

ing equipment for the purpose of removing the impurities from the feldspar by mechanical means. Poor results were obtained in all cases, except with a Rowand-Wetherill magnetic separator equipped with 120,000-ampere turn coils. This separator produced fair results, its chief defect being the small production of $^1/_4$ ton per hour for each two-pole separator.

Plant operation of these units indicated that a closely sized, granular dry feed, one layer deep, was necessary, and that feldspar finer than 80-mesh could not satisfactorily be separated from its impurities.

To provide these separators with a feed finer than 14-mesh (which is the point where the impurities are unlocked from this particular feldspar) and retained on 80-mesh, required an entirely new process of crushing feldspar.

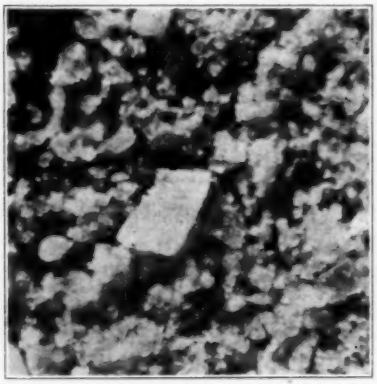

FIG. 1.—Ordinary ground 20-mesh feldspar showing wide range of grain sizes. Magnification 20 ×.

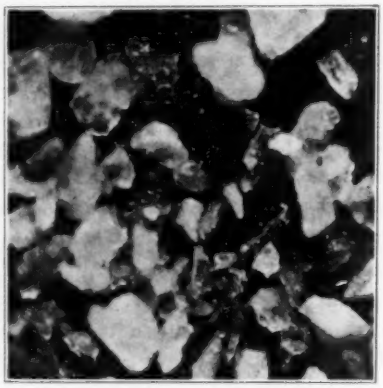

FIG. 2.—Granular feldspar. Note narrow range of grain sizes and absence of dust. The grains are practically uniform in size. Magnification 20 ×.

To ascertain the possibilities of producing a product within the narrow range of minus 14- plus 80-mesh, tests were conducted on all available types of pulverizing equipment with the result that crushing rolls were selected because of their ability to produce a granular product with a minimum of fines.

Plant operation of crushing rolls indicated that best results could be obtained by the use of three sets of crushing rolls arranged for stage crushing, as the correct sized material could be removed with screens from the circuit as soon as produced, thus increasing crushing efficiency and reducing the amount of dust.

By employing Rowand-Wetherill magnetic separators for removing impurities, this plant made possible for the first time the mechanical separation of iron-bearing minerals from feldspar. All operations, from the mining of the crude rock to the grinding of the purified feldspar, embodied a

continuous mechanical process, the usual hand sorting being entirely eliminated.

III. Induction Magnetic Separation

Operating experience indicated that it would be necessary to secure a high-power magnetic separator having revolving magnetic surfaces over which the material to be purified could be passed. In such a machine the chief defect of the Rowand-Wetherill type would be overcome, as it would not be necessary to raise the feebly magnetic, iron-bearing minerals from the feed against the force of gravity. The impurities, furthermore, would be in contact with the magnets, causing more efficient action of the magnetic flux on the impurities.

Based on results obtained with several test machines, a full-size commercial separator was constructed with two 140,000-ampere turn coils.

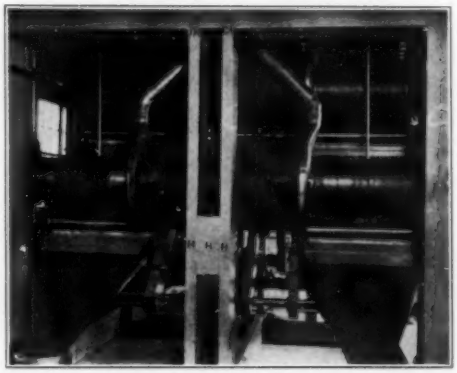

FIG. 3.—Induction magnetic separator (front view).

The induction magnetic separator as shown in Fig. 3 has two magnet coils superimposed over ten revolving, laminated, magnetic rotors. Five rotors, in parallel, are located on each side of the machine, feed hoppers being located at the head of each of the two top rotors.

The special rotor design provides for a high flux density for unit area of rotor surface. The upper six rotors are energized by induction by the upper coil; the lower four rotors are energized by induction by the lower magnet coil.

Highly magnetic material, such as free iron, is removed by the first rotor and feebly-magnetic materials are removed by the four lower rotors. Magnetic particles (tailings) are attracted or held to the rotors which drop them before half a revolution is made due to a change in polarity of the rotors. Feebly-magnetic materials, such as muscovite mica, are attracted out of and diverted from the falling stream of material passing over the rotors to the chutes. The concentrates fall from the rotors to chutes, which in turn feed the succeeding rotors, so that five successive treatments are received by the material passing through the separator. In this way complete removal of all iron and iron-bearing minerals is effected.

IV. Results

The results obtained with this new improved, dry method of separation are indeed astounding.

Figure 4*A* shows minus 20- plus 40-mesh granular run-of-mine feldspar containing 1.38% Fe_2O_3, mainly in the form of free iron and biotite mica. The concentrates obtained by induction separation from this product are shown in Fig. 4*B*. The iron content has been reduced to 0.12%. Tailings removed from the original material are indicated by Fig. 4*C*. When separating material of this kind and size tailings losses average 17%. Separa-

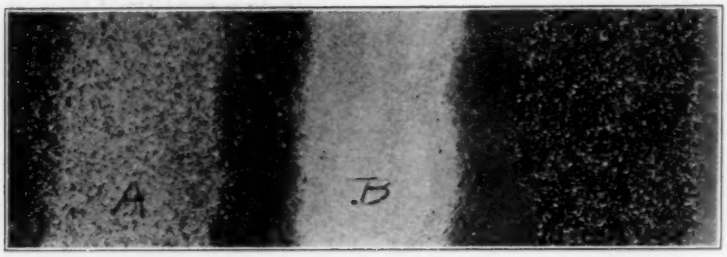

FIG. 4.—*A*, original run-of-mine. *B*, concentrates. *C*, tailings. Actual grain size.

tion of the minus 40-mesh feldspar can be effected with a reduction of the iron content to 0.11%, with a tailings loss averaging 20%.

Fusions of the ground products shown in Fig. 4 are represented in Fig. 5:

A represents the original run-of-mine feldspar.
B represents the concentrates.
D represents the tailings.

The fusion, Fig. 5*C*, is representative of concentrates obtained using the same feed, with Rowand-Wetherill magnetic separators, with a production of two tons per hour similar to the induction magnetic separator. The iron content of the fusion is 0.38%, which fusion also indicates the inefficiency of this type of separator as compared to the induction type having the same production and feed.

A fused specimen of run-of-mine crude feldspar containing an unusually large amount of impurities (black mica) is shown in Fig. 5*E*. This piece of feldspar would be discarded as waste if hand selection was used to separate impurities from clean feldspar. Run-of-mine feldspar of this kind, after granulation with crushing rolls to minus 20- plus 40-mesh, is shown in Fig. 4*A* (actual size of grains). Note that the impurities, which are visible

as black specks, are unlocked or freed from the feldspar. In this condition the material can be purified to produce a low iron content feldspar as shown in Figs. 4*B* and 5*B*.

Figure 5*F* represents the fusion product of run-of-mine North Carolina ground feldspar containing 0.18% Fe_2O_3. Most of the iron has been introduced by muscovite mica, garnet, and smaller amounts of biotite mica. The fused ground concentrates obtained from this product after

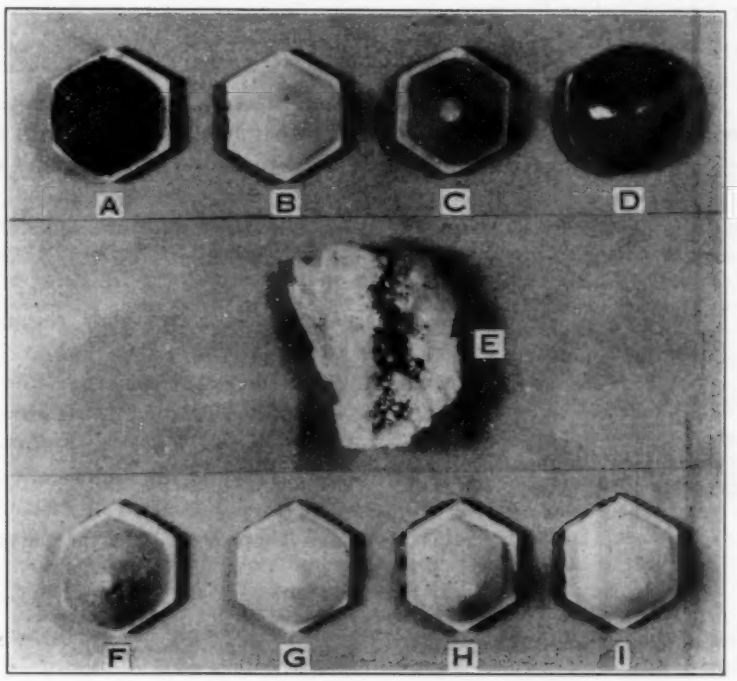

FIG. 5.

induction magnetic separation are represented by Fig. 5*G*. The iron content of the concentrates has been reduced to 0.07%, which figure represents a lower iron content than most hand-selected feldspars.

To show comparative differences between hand-selected and induction magnetically-separated feldspar, Fig. 5*H* represents a fusion of hand-selected feldspar containing 0.12% Fe_2O_3. The specimen is rather specky due to the presence of a small amount of free iron introduced in the product from crushing machinery. The presence of the usual iron-bearing impurities also adds to the specks and color of the fused feldspar. This product, after separation with the induction magnetic separator, is

represented by Fig. 5*I*. The color has been improved, the specks are absent, and the product contains only 0.05% Fe_2O_3.

This improvement in the product has been accomplished by the removal of practically all iron-bearing minerals which are usually associated with feldspar, such as the various micas, garnet, hornblende, tourmaline, and hematite. In this instance, the inefficiency of hand selection is apparent as a considerable amount of deleterious minerals (the amount depends on the care exercised in selection) have been extracted from the product after hand selection has been employed.

V. Granular Feldspar (Glasspar)

It was realized that glass manufacturers desired a granular feldspar for use with the other granular materials in the batch. To comply with their specifications, the maximum size particle fed to the separator is finer than 20-mesh.

Feldspar producers have found it a problem to maintain shipments of feldspar within the limit of 0.10% Fe_2O_3 demanded by most glass specifications. Induction separation indicates that shipments containing from 0.04% to 0.06% Fe_2O_3 can consistently be made. The uniformly low iron content of the finished product is remarkable.

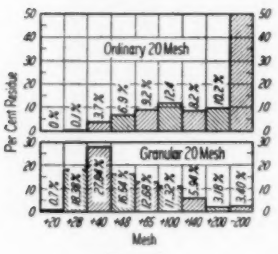

FIG. 6.

Shipments indicate that a more uniform product, both chemically and mineralogically, can be produced by the elimination of deleterious minerals from feldspar by induction separation.

VI. Conclusions

The process of induction separation makes possible the production of feldspar whose iron content is uniformly low.

Hand-selected feldspar can be improved in quality by the complete removal of deleterious minerals whereby the iron content is reduced to a minimum and specks are eliminated from the fused product.

Run-of-mine feldspar can be converted by induction separation into a low iron product whose color is equal or superior to hand-selected feldspar. Depending upon the consumer's specifications to be met, this product can be further improved in quality by the removal of either part or all of the free quartz.

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CERAMIC ABSTRACTS[1]

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Vol. 10 **May, 1931** **No. 5**

Abrasives

Hollow-ware grinding data. Anon. *Abrasive Ind.*, **12** [3], 32 (1931).—A so-called hollow-ware grinder is a special machine equipped with a spindle fitted with a chuck for holding the work and means for rotating and feeding the work. The work-spindle housing is provided with a rocking motion controlled by a hand lever to feed the work past the wheel. The wheel is mounted in a holder which slides longitudinally to control the depth of cut. The various motions necessarily must be flexible to permit the wheel to conform to the shape of the stock. Otherwise an excess amount of material would have to be removed to clean up specific surfaces. Wheels for hollow-ware grinding are of silicon carbide and are operated at approximately 4000 ft. per min. peripheral travel. The wheels used are of special shapes, termed "skillet wheels" and "pot balls." They usually are of 36 grit in a hard grade. In hollow-ware grinding the wheel conforms to the shape of the work. Illustrated. E.P.R.

Constant cutting speed. Anon. *Abrasive Ind.*, **12** [3], 35 (1931).—The Black & Decker Mfg. Co. has introduced a 24-in. stand grinder with an automatic speed control to maintain 6000 or 9000 surface ft./min. By maintaining constant cutting speed the life of the grinding wheel is lengthened and metal is removed quicker with less effort on the part of the operator. This speed is controlled and maintained by means of a rheostat link connected to the guard. As the guard is moved forward to follow up the wheel wear, the speed of the motor is automatically advanced. E.P.R.

Huge roll grinder is completed. Anon. *Abrasive Ind.*, **12** [3], 34 (1931).—What is believed to be the largest traversing table grinding machine in the world has just been completed by the Norton Co. It will grind work up to 36 in. in diameter, 288 in. in length, and the limit of allowable weight is 40,000 lb. The machine will grind to a mirror finish and within extremely close limits of accuracy; easily within 0.0005 in. for concentricity and straightness. It has a production rate of several times that of the average cylindrical grinding machine of medium size. In a trial it removed stock from a large cast-iron column at the rate of 6 cu. in. a minute. The machine was built for the Southwark Foundry & Machine Co., Philadelphia. It will be used principally for grinding rams and columns for mammoth hydraulic presses at the Eddystone plant of this company. It will permit finish grinding direct from rough turning, effecting a considerable saving over the former method of finish turning and polishing with the obvious higher degree of accuracy and better quality of finish. E.P.R.

[1] The abbreviation (*C. A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.
The bold-face number following the journal name is the volume, the issue number is in brackets, followed by the page numbers, then the year in parentheses.

Truing formed wheels accurately. ANON. *Abrasive Ind.*, **12** [3], 36 (1931).—A device for truing three radii on the two sides and the face of a grinding wheel has been recently designed by the Brown & Sharpe Mfg. Co. The device consists of a base bolted to the table of the machine on which is mounted a swiveling member. Three positive positions are provided for this member, each being a position from which one truing operation on the wheel is done. Incorporated in the construction of the swiveling member and bolted rigidly to it is a former shaped to the required radius. The diamond tool holder is carried on a pair of slides mounted on the swiveling member. These slides are at right angles to each other giving the holder both longitudinal and transverse movements. A follower forms a part of the slides and by means of spring tension this follower is kept in contact with the former. As the slides carrying the diamond are moved back and forth by a hand lever along the contour of the former, the diamond travels in a path parallel to the contour of the former. E.P.R.

Sparking-out attachment for automatic internal grinders. ANON. *Abrasive Ind.*, **12** [3], 33–34 (1931).—The Heald Machine Co., Worcester, Mass., has developed sparking-out attachments for its automatic sizing and automatic gaging internal grinders. E.P.R.

New motor development for preliminary and fine grinding machinery. R. S. WRIGHT. *Pit & Quarry*, **21** [11], 24–26 (1931). E.P.R.

Grind bevels and tapers. ANON. *Abrasive Ind.*, **12** [3], 37 (1931).—To facilitate the grinding of bevels and tapers and for general tool room work, the J. & H. Electric Co. developed the combination swivel-taper magnetic chuck, available in 5 x 13 and 7 x 16 in. sizes. Essential parts are a base, cradle, and trunnioned magnetic chuck. The base clamps to the machine and carries the cradle (pivoted at one end), elevating screws, indicator plates, and pointers for taper grinding. The cradle has as an integral part, capped bearings for the turned trunnions on the chuck. E.P.R.

Redesign gear grinder. ANON. *Abrasive Ind.*, **12** [3], 17 (1931).—The Pratt & Whitney Co. has purchased all patents and manufacturing rights of the Garrison gear grinder, a machine originated by the late Orlando Garrison and built and sold by the Garrison Gear Grinder Co. E.P.R.

New high-speed air grinders. ANON. *Brass World*, **27** [2], 42 (1931).—The Madison-Kipp Corp. recently announced the addition of three new ball-bearing, high-speed models to its line of air grinders operating at 60,000 to 100,000 r.p.m. E.P.R.

Fitting aircraft tubing. JOHN L. ALEXANDER. *Abrasive Ind.*, **12** [3], 15 (1931).—An inexpensive type of tube fitting machine is composed of a 1 h.p. vertical electric motor which carries three grinding wheels. This motor can be raised and lowered instantly so as to bring the right sized wheel to the correct grinding position. The tube to be fitted is placed in a horizontal plane at the required angle and the motor-driven wheel is passed by it only once and the job is finished. E.P.R.

Design abrasive cut-off machine. ANON. *Abrasive Ind.*, **12** [3], 35–36 (1931).—An abrasive cut-off machine has recently been developed by the Cochrane-Bly Co. and was designed with the idea of obtaining better wheel efficiency and increasing the rate of cutting and the number of cuts for a given amount of wheel wear. The machine has a hardened and ground spindle mounted in dust-proof roller bearings and a heavy carriage mounted on ball-bearing ways giving free and easy movement of the carriage, which is moved to the work by means of a lever giving a ratio of about three to one. E.P.R.

Grinds out-of-balance steering knuckles. ANON. *Abrasive Ind.*, **12** [3], 35 (1931).—Two diameters of dynamically and statically unbalanced steering knuckle shafts are ground simultaneously and quickly by a unique set-up on a grinding machine made by Cincinnati Grinders, Inc. A double grinding wheel mount is used with the wheels profiled to grind both diameters in one cut by the in-feed method. Illustrated. E.P.R.

Automatic machines assure high output. ANON. *Abrasive Ind.*, **12** [3], 38–40 (1931).—The Hoover Co., makers of electric cleaners, operates an extensive polishing department equipped with over 50 electrically-driven lathes of the most modern types. E.P.R.

Grinds locomotive axles. ANON. *Abrasive Ind.*, **12** [3], 22 (1931).—The Niles Tool Works Co. has developed a machine for grinding locomotive axle journals. The machine is arranged to swing wheel sets having 90-in. diameter drivers and to grind inside journals of from 12 in. to 18 in. in length. Illustrated. E.P.R.

Journals and crankpins ground in German practice. S. WEIL. *Abrasive Ind.*, **12** [3], 18–19 (1931).—A grinding machine for truing the rims of wheels, axle journals, and crankpins is manufactured in Germany as a specialty by Schmaltz Co., Ltd., Offenbach on Main. Illustrated. E.P.R.

Automotive regrinders must sell accuracy. R. G. PATTERSON. *Automotive Rebuilder; Abrasive Ind.*, **12** [3], 20–22 (1931).—The subjects of honing, boring, and grinding as pertaining to the reconditioning of automotive engine cylinders are discussed. E.P.R.

Exhibit grinders. ANON. *Abrasive Ind.*, **12** [3], 17 (1931).—Among the shop equipment exhibits at the Cleveland Automobile show held in the Cleveland Public Auditorium, Jan. 26–30, were a number of abrasive tools. The Black & Decker Mfg. Co., Baltimore, showed its electrically driven valve refacing machines and several models of ball-bearing bench grinders accommodating wheels 6, 7, and 10 in. in diameter. There also were on exhibition valve-facing grinders made by the Albertson & Son, Inc., Sioux City, Ia., together with bench and flexible shaft grinding equipment. E.P.R.

Spindles of lathe are independent. ANON. *Abrasive Ind.*, **12** [3], 37 (1931).—An independent spindle, motor-driven polishing and buffing lathe, developed by Charles F. L'Hommedieu & Sons Co., is designed for high production and incorporates safety features to protect the operator. The independent spindles operate in dust-proof antifriction bearings while the drives are by 4-sheave V-belts from motors mounted in the base. Each motor is independent of the other and the sheaves can be removed readily and others substituted when it is necessary to make speed changes. Illustrated. E.P.R.

Automatic metal polisher. ANON. *Brass World*, **27** [2], 36 (1931).—Three operations with one handling of the article is the chief feature of a new type of automatic polishing machine that has been placed on the market by the C. I. Packer Tool & Die Co. This machine is known as the "Cipco." The manufacturer states it is adaptable to many kinds of work measuring up to $7^1/_2$ in. in diameter. Change-overs are said to be rapid due to specially designed expansion chucks. E.P.R.

New Rockhard polishing wheel. ANON. *Amer. Glass Rev.*, **50** [23], 16 (1931).—A new type of cork polishing wheel offered by Ferdinand Gutmann & Co., is composed of select shavings of cork wood which have been subjected to special chemical treatment so that they readily take the polishing compound. This wheel is especially adapted to polishing mitres, cut glass, etc., where the face of the wheel requires shaping. E.P.R.

Stand for balancing polishing wheels. ANON. *Brass World*, **27** [2], 41 (1931).—The Excelsior Tool & Machine Co. has devised a stand having two runners and an arbor by means of which wheels may easily be tested for balance. E.P.R.

Fine red polishing rouge. ANON. *Nat. Glass Budget*, **46** [42], 5 (1931).—This rouge is especially suitable for use when the glass polished is to be utilized in the manufacture of mirrors and for other purposes where quality product is demanded. E.P.R.

Polishing and buffing glossary. ANON. *Abrasive Ind.*, **12** [3], 42–43 (1931).—

Presentation of a glossary of polishing and buffing terms representing a consensus of opinion in the industry forms the basis of this nomenclature, the first instalment of which is presented in this article. E.P.R.

BULLETINS AND CATALOGUE

Grinding and polishing. ANON. *Abrasive Ind.*, **12** [3], 37 (1931).—Norton Co. has issued an interesting booklet showing advantages of flexible grinding which is a better term for describing polishing in the metal-working industries. E.P.R.

Buffs and polishing compositions. ANON. *Brass World*, **27** [2], 37 (1931).—The booklet, Bulletin B-101, issued by the Hanson-Van Winkle-Munning Co., gives full descriptions of a large variety of buffs, with illustrations showing the manner of construction of the buffs. E.P.R.

No. 30 catalogue of mechanical rubber goods. ANON. *Abrasive Ind.*, **12** [3], 31 (1931).—This catalogue, issued by the New York Belting & Packing Co., has a section devoted to rubber-bond grinding wheels. Various wheel-face shapes are illustrated and a table is included which gives peripheral speeds in surface feet per minute in increments from 5000 to 10,000 and in diameters from 1 to 30 in. E.P.R.

PATENTS

Centerless grinder. JOHN E. CASTER AND LESTER F. NENNINGER. U. S. 1,791,713, Feb. 10, 1931. A grinding machine including a grinding wheel, a work-supporting blade disposed adjacent the grinding wheel, and extending transversely of the operative face thereof to peripherally engage a work piece and support it against the thrust of the grinding wheel, means for resiliently urging work on the blade in the direction of the grinding wheel and means for limiting the movement of the work as resiliently urged.

Abrasive wheel. JOHN R. GAMMETER. U. S. 1,792,083, Feb. 10, 1931. An abrasive wheel construction including an abrasive wheel body formed with spiral grooves in its opposite faces, wire convolutions wound while hot in the grooves and permitted to shrink therein, and layers of tough, plastic material cured under pressure over the wire convolutions to bond the wire convolutions to the faces of the wheel.

Grinding machine. HARRY HALES ASBRIDGE. U. S. 1,794,271, Feb. 24, 1931. In roll grinding machines, in combination, a grinding wheel, a slide reciprocable upon the machine bed, a roll support swiveling about a vertical pivot upon the slide.

Grinding machine. RALPH MERSHON. U. S. 1,794,975, March 3, 1931. A machine for the grinding of tapered articles comprising a pair of opposed wheels having surfaces forming an included angle corresponding to that to be produced on a work piece, means supporting a work piece for axial rotation, one of the wheels being rotatable at a relatively slow rate of speed to control the rate of rotation of a work piece engaged thereby, the other of the wheels being rotatable at a grinding rate of speed to generate the prescribed surface of revolution on the work piece as it is rotated about its axis by the slow-moving wheel, and means for shifting a work piece transversely of the surface in a plane bisecting the angle between the surfaces.

Segment for use in grinding wheels. FRANK E. STRATTON. U. S. 1,794,992, March 3, 1931.

Means for holding normally reciprocating spindles from reciprocating. CONRAD OTT. U. S. 1,795,230, March 3, 1931.

Grinding knife blades. F. HENDRICHS. Brit. 339,857, Feb. 4, 1931. Knife blades to be ground are reciprocated in contact with a grinding wheel in carriers revolving coaxially with the wheel, the carriers being withdrawn at a point in the circular path by stops for exchanging the blades, which are subjected to grinding under pressure and then to fine grinding under small pressure in the same operation.

Art and Archaeology

Copper red glaze. III. TOSAKU YOSHIOKA AND SHO HIRAOKA. *Jour. Jap. Ceram. Assn.*, **37** [440], 335–41 (1929).—Tests were made on firing of copper red glaze. The glazes were applied on pieces made of a Seger body composed of Katogun kaolin 25, feldspar 30, and quartz 45, and biscuited at 850°C. Results: (1) *Base glaze.* The base glaze must be rich in lime and contain 0.3 mol. Al_2O_3, 3.0 SiO_2, and some boric acid. The glaze chosen is $0.25\ Na_2O{\cdot}0.15K_2O{\cdot}0.60CaO{\cdot}0.25Al_2O_3{\cdot}3.00SiO_2{\cdot}0.25B_2O_3$. Its batch must be fritted together with colorant. (2) *Colorant.* The best proportions are 0.3 to 0.5% $CuCO_3$. (3) *Auxiliary colorant.* Fe_2O_3 and SnO_2 are best. Fe_2O_3 tends to give a gloomy gray shade, whereas SnO_2 makes the color clear and beautiful. The amount of tin oxide must be less than 3 times that of CuO to obtain an unclouded glaze. (4) A neutral atmosphere as CO_2, N_2, or steam is better than a reducing one. The presence of steam prevents the glaze from oxidation and makes the coloring colloidal particles disperse uniformly and in suitable size. (5) The glaze must be cooled quickly after melting, *i.e.*, at 1300°, and then be kept at a constant temperature of about 700° for a constant time, *i.e.*, 30 min. (6) The red coloration due to copper is a colloidal phenomenon. At the melting point, the glaze is an oversaturated true solution of copper. When it is cooled quickly down to the softening temperature, it is an over-cooled solution. At this annealing temperature crystal germs are produced spontaneously and a colloidal solution or a suspension of submicrons, which may be Cu_2O or other oxides lower than CuO, is formed, since the viscosity of the glass is high so that the rate of crystallization is kept smallest. For Part II see *Ceram. Abs.*, **8** [9], 622 (1929).

S.K.

Turquoise glazes on yellow- and red-fired bodies. ARNULF HOLL. *Keramos*, **10** [1], 23–25 (1931).—Turquoise glazes are pronounced alkali glazes which develop a blue color with an addition of 2 to 4% copper oxide. These glazes are translucent and therefore are used on white or yellow-white bodies. It is also possible to use them for red fired clay without much injury to the blue color. The opacity of the turquoise glaze is effected by zinc oxide, chalk, feldspar, and tin oxide. Turquoise glazes are fritted. A slow and uniform fusing on during fritting is required. They must be finely ground. Muffle kilns or saggers with an oxidized flame are used for firing. The following turquoise glazes may be of interest:

(1)	$0.8\ Na_2O$ $0.2\ ZnO$	$2\ SiO_2$ $0.1\ SnO_2$		$Na_2CO_3+10H_2O$	228.8	parts by	weight
				ZnO	16.2	" "	"
				SiO_2	120.0	" "	"
				SnO_2	15.1	" "	"
(2)	$0.6\ Na_2O$ $0.3\ ZnO$ $0.1\ CaO$	$2\ SiO_2$ $0.1\ SnO_2$		$Na_2CO_3+10H_2O$	171.6	" "	"
				ZnO	24.3	" "	"
				$CaCO_3$	10.0	" "	"
				SiO_2	120.0	" "	"
				SnO_2	15.1	" "	"
(3)	$0.6\ Na_2O$ $0.1\ K_2O$ $0.2\ ZnO$ $0.1\ CaO$	$0.1\ Al_2O_3$	$2\ SiO_2$ $0.1\ SnO_2$	$Na_2CO_3+10H_2O$	171.6	" "	"
				$K_2O{\cdot}Al_2O_3{\cdot}6SiO_2$	55.9	" "	"
				ZnO	16.2	" "	"
				SiO_2	84.0	" "	"
				SnO_2	15.2	" "	"
(4)	$0.5\ Na_2O$ $0.1\ K_2O$ $0.3\ ZnO$ $0.1\ CaO$	$0.1\ Al_2O_3$	$2\ SiO_2$ $0.1\ SnO_2$	$NaCO_3+10H_2O$	143.0	" "	"
				$K_2O{\cdot}Al_2O_3{\cdot}6SiO_2$	55.9	" "	"
				ZnO	24.3	" "	"
				$CaCO_3$	10.0	" "	"
				SiO_2	84.0	" "	"
				SnO_2	15.1	" "	"

(5)	0.5 Na_2O } 2 SiO_2	$Na_2CO_3+10H_2O$	143.0	parts by weight
	0.3 ZnO } 0.1 SnO_2	ZnO	24.3	" " "
	0.2 CaO	$CaCO_3$	20.0	" " "
		SiO_2	120.0	" " "
		SnO_2	15.1	" " "
(6)	0.5 Na_2O } 1.6 SiO_2	$Na_2CO_3+10H_2O$	143.0	" " "
	0.4 ZnO } 0.1 SnO_2	ZnO	32.0	" " "
	0.15 CaO	$CaCO_3$	15.0	" " "
		SiO_2	96.0	" " "
		SnO_2	15.1	" " "
(7)	0.4 Na_2O } 1.6 SiO_2	$NaCO_3+10H_2O$	114.4	" " "
	0.4 ZnO } 0.1 SnO_2	ZnO	32.0	" " "
	0.2 CaO	$CaCO_3$	20.0	" " "
		SiO_2	96.0	" " "
		SnO_2	15.1	" " "

All these glazes are fired at 960 to 980°C and 3% copper oxide must be added to all batches to obtain a strong turquoise blue. The composition No. 1 is easily fusible and produces a deep blue. No. 2 produces an intense blue. No. 3 has a half mat character and the color is intense. No. 4 is a pronounced turquoise blue, has completely opaque action, and an exceptional luminosity. No. 5 is a beautiful but transparent turquoise; it is good for pale clays. No. 6 is similar to No. 4 in color tone and completely opaque. No. 7 is white-blue green. M.V.K.

Decorative brick construction. MARC N. GOODNOW. *Christian Sci. Mon.*, **23** [74], 8 (1931).—It is possible through softly blending colors, different textures, and irregular shapes in brick to arrive at something unusual and attractive and at the same time preserve fundamentals of sound architecture and construction. There is also a wide field of opportunity in patterns, bonds, and mortar joints. By their use, solid or flat lines or surfaces may be broken up into decorative units. Illustrated. E.J.V.

Modern windows in colorful designs of rich glass and lead. ANON. *House & Garden*, p. 60 (Jan., 1931). (*D.I.*)

China and glassware. ANON. *Pottery Glass & Brass Salesman*, **42** [22], 19 (1931).—(1) The Fostoria Glass Co. is displaying a new three-piece tomato cocktail set. (2) Nagoya Seitosho, Ltd., has a new dinnerware known as the "Fuji" shape. (3) Jay Wolfred, Inc., has many novelties in imported potteries. Two outstanding lines are the Tuscany pottery and the "Verdino" pottery. *Ibid.*, **42** [23], 13 (1931).—(1) The American Chinaware Corp. has presented a new "Briar Rose" shape in dinnerware. (2) A. H. Heisey & Co. has a new pressed shape in stem and blown ware. (3) The Rowland & Marsellus Co. has reproductions of old authentic museum pieces. *Ibid.*, **42** [24], 19 (1931).—(1) The Rosenthal China Corp. has developed new bodies and shapes ranging from perfect reproductions of types of 1710 up to decorative treatments of the present time. (2) Justin Tharaud, Inc., has recently displayed a new square shape and a pattern known as the "Sèvres." (3) Groh, Newland & Schneeloch is displaying a line of Tolpen products including hand-painted and gold-encrusted treatments. *Ibid.*, **43** [1], 12 (1931).—(1) Copeland & Thompson, Inc., is showing a variety of outstanding Spode and unusual patterns on the "Centurion" shape. The following patterns are featured: (*a*) Crow's-Feet, (*b*) Kew, (*c*) Bamboo, (*d*) Cynthia, and (*e*) Wisteria Chintz. (2) McKenna Bros. Sales Corp. has a variety of new items in cut and decorated glassware in unusual colors. (3) Homer Laughlin China Co. has made a new noncrazable glaze which is applied to the "Canterbury" shape in Wells ware. E.P.R.

Modern window designs. ANON. *Glass Ind.*, **12** [3], 51 (1931).—The Paris publication, "The Week in Paris" has modern window designs in its new offices. Each section of the window represents a different day of the week and each section is included

in a different one of the private offices in the building. The windows are made of shades of white, gray, and black glass supported in frames of forged iron. Illustrated. E.J.V.

New phases of Swedish art. GUILLAUME JANNEAU. *Mobilier et Décoration*, pp. 180–87 (Nov., 1930).—The national Swedish taste prefers the simple effects that are consistent with the nature of the material to those that are pretentious. Recent work at the Orrefors glass factory and new designs for metal work and pottery show the expression of a national spirit in other media. (*D.I.*)

New porcelains of the Bing and Grondahl factory, Copenhagen. ANON. *Mobilier et Décoration*, pp. 194–99 (Nov., 1930).—In 1925, the porcelain factory at Copenhagen began to experiment with effects of white and pale colors. This gives a fragility that accords well with modern taste. The decoration is done in enamel under the glaze, which is often crackled in the Chinese manner. The effect is one of singular grace and delicate finish. (*D.I.*)

New lamps. ANON. *Christian Sci. Mon.*, **23** [32], 9 (1931).—Some of the newer designs in table, floor, and bridge lamps made of newer types of glass are described. "Rimpled," or slightly frosted glass, "firelight," glass tinted yellow to flame, and spun glass are used. Illustrated. E.J.V.

Decorating with light. CLARA BELL WOOLWORTH. *Christian Sci. Mon.*, **23** [68], 8 (1931).—In this discussion of the various modern types of lighting fixtures, considerable attention is paid to modern glass shades and fixtures. Illustrated. E.J.V.

Artist and artisan coöperate. ANON. *Christian Sci. Mon.*, **23** [84], 6 (1931).—Advances in better production have been made in Dutch glass and pottery works, where the Glasfabriek Leerdam has taken the lead, and produces new designs after the models of the most progressive designers. Some of the new products are described. Illustrated. E.J.V.

New shapes in flower vases. ANON. *Christian Sci. Mon.*, **23** [73], 6 (1931).—Among the new shapes introduced by English, Italian, Danish, and Czechoslovakian glassmakers are tumbler-shaped vases, slightly tapering bowls having a foot, a squat shape with a very wide turnover flange, and a perfectly plain cylinder. These are produced in many new colors and color combinations. Illustrated. E.J.V.

Eglomise glass. C. A. COOK. *Notes & Queries*, **159**, 350 (1930).—Eglomise is derived from the name of a Parisian picture-framer, Glomy, the formative verb being églomiser. The process consists of ornaments painted, gilded, or enameled on the underside of glass so as to show through. H.H.S.

Design, the indispensable. ISABEL PEARL SNELGROVE. Univ. of N. D., *School of Education Rec.*, pp. 101–107 (Jan., 1931).—Designers have so adapted their designs to the necessities of the machine and the machines have been so adjusted to the requirements of art, that at the present time numerous machine-made products of high artistic merit are on the market. (*D.I.*)

Relation of art in industry. FRANCES PARSONS DAVIS. *World Mag.*, pp. 4–5 (Jan. 11, 1931).—The industrial designer is the artist who sees a connection between beauty, efficiency, and sales records. (*D.I.*)

Necessity of art exhibits. W. M. *Deut. Kunst & Dekoration*, pp. 196–98 (Dec., 1930).—The trend is away from large expositions. Often they profit neither art nor industry. The chief value of an art exhibit lies in its ability to express the spirit of the time, admirable or deplorable. As an expression of contemporary life the art exhibit is essential. (*D.I.*)

The artistic trinket. B. DELISLE. *Mobilier et Décoration*, pp. 205–209 (Nov., 1930). (*D.I.*)

New Italian ceramics. CARLTON ATHERTON. *Design*, **32** [8], 178–79 (1931).—

The 4th Triennial International Exposition at Monza, Italy, seems to indicate that the arts and crafts movement sponsored by King Victor Emanuel III and organized by Signor Mussolini is endeavoring to recapture the past glories of Italy. Italian arts and crafts are now an integral part of industrial production. Famous artisans are concentrating upon fine manufactured arts as well as studio craftsmanship. Illustrated.
E.B.H.

New discoveries in Mexican clay. WILLIAM SPRATLING. *Studio*, **98** [405], 22 (1931).—Three unusual types of native pottery, all a pale coffee color, have come to light in the Mexican state of Guerrero. In Tuliman, the turning of the clay, which is placed upon two inverted plates, is done with the foot. After drying, the design is painted with a brush made from wood and with color of pure earth, approximately black. The motifs are stylized birds, sun, maize, and sometimes mere signs quite Chinese. Tixtla pottery is still more Oriental. Although flecked with particles of pure gold, this detail is not so definite as its distinct primitive design. The most highly-developed culturally is from Guapa, the three-handled water jars being outstanding. A Guapa motif common to all its pieces is drawn from the plain grass. Natives claim it has come down from "father's father." Pieces are produced from a single lump, coated with white clay, painted with designs of red- or violet-brown, polished when dry with a smooth stone, and baked in an open fire, being turned by hand. Extremely thin and light, the secret is the use in the clay body of a fine, white fiber of a wild plant which gives plasticity and strength. Illustrated. E.B.H.

Industrial art in Germany. WILHELM LOTZ. *Amer. Mag. Art*, **22** [2], 103–108 (1931).—Workshops where goods are still made by hand are found in every branch of industry. In surveying modern industrial tendencies it is apparent that (1) in all spheres of productions we are quite stylistically behind the times, (2) a growing increase in the number of accepted modern designs, (3) a tentative attempt to supply good single pieces which may be combined to suit individual needs, (4) innovation in substitution of steel for woodwork in combining glass with metal as fulfilling demand for cleanliness, hygiene, and directness of form, (5) creation of lighting from technical point of view and, (6) movement in glass and pottery industry is slow because of little alteration in factories and the temptation of the materials to become decorative and playful. E.B.H.

Pottery for the modern home. ANON. *Sphere*, p. 31 (Jan. 3, 1931).—A comparison of modern pottery from Paris with the latest English ware is given. (*D.I.*)

Chinese enamels. FRANK DAVIS. *Illus. London News*, **177**, 1138 (1930).—Although Chinese enamels have not the importance of European Middle Ages and Renaissance enamels, it is the superiority of Chinese porcelain which has overshadowed them. Illustrated. H.H.S.

Industry and decorative art in Kashmir. W. BOSSHARD. *Discovery*, **12**, 7–11 (1931).—An illustrated account is given of Kashmiri silk, carpets, pottery, etc.
H.H.S.

Color in modern life. ANON. *Chemicals*, **35** [2], 24 (1931); *Science*, pp. 69–70 (Jan. 16, 1931).—Recent contributions of the chemist to present-day knowledge and use of color in our industrial civilization were a feature of the Exhibition on the Science and Art of Color given by the Museum of Science and Industry of New York, January.
G.R.S.

Glassware exhibit in Pittsburgh. ANON. *Amer. Glass Rev.*, **50** [16], 15–16 (1931); *Ceram. Ind.*, **16** [2], 190–96 (1931).—New colors and shapes in crystal were featured at the 51st Annual Pittsburgh Glass and Pottery Exhibit in January. E.P.R.

Frank Brangwyn's designs for British industry. C. G. HOLME. *Studio* [London], **100**, 440–45 (1930).—An exhibition has been held in London of Doulton pottery, James Powell glass, and carpets and furniture by other makers, the common factor being

that they were designed by Brangwyn. A colored plate of Doulton tea-service is shown. H.H.S.

American glassware. WALTER RENDELL STOREY. *Nat. Glass Budget*, **46** [45], 25 (1931); *Amer. Glass Rev.*, **50** [22], 22 (1931).—Patterns of glass tableware from Sandwich, Pittsburgh, and New Jersey towns contain references to every-day and historical events. Interesting pieces of early glass of this era may be seen in the collection of Mrs. Sarah Benham at the A. L. Brandon Gallery, New York. It was not until the industrial era of the early 19th century that glassblowing achieved a distinctly American character. The Stiegel and Wistar glass of the 18th century was modeled closely on European styles, incorporating the Venetian glassblower's art, the skill of the English engraver, and the enameling of the German artisan, but the American invention permitted the making of glassware in molds of "pressed glass," giving a distinctly local feeling to the pieces. See also *Ceram. Abs.*, **10** [3], 167 (1931). E.P.R.

Follansbee collection. GRACE V. KELLY. *Cleveland Plain Dealer*, No. 90, p. 67 (1931).—Mrs. George E. Follansbee, of Cleveland, Ohio, has for thirty years been collecting early American pottery and glassware. In her collection can be found blown glass made in New England in 1730 and in Ohio in 1800, while the Sandwich glass, which is pressed, began in 1827. In the pottery section there are some 800 crack pieces, glazed and unglazed, and ranging from warm gray through deep red and violet-browns to almost black. One piece in orange and black is very rare. Particular pieces are described in detail. Illustrated. E.J.V.

Antique glass bowl. ANON. *Nat. Glass Budget*, **46** [39], 26 (1931).—A Stiegel cobalt-blue glass sugar bowl with cover, made in Pa. in the late 18th Century, sold for $525 at the sale of the Francis P. Garvan collection of Americana at the American Art Anderson Galleries. E.P.R.

Women potters of Ildefonso. R. L. B. *Christian Sci. Mon.*, **23** [18], 7 (1931).—While all women in the Indian pueblos of San Ildefonso, N. M., are potters, Maria Martinez is their outstanding artist. For 14 years Maria experimented with different clays and minerals for molding and painting her pottery and with varying lengths of time for firing. Ten years ago she produced dull black decorations on the polished black jars. The process is still the primitive building up of rings of clay, polished when dry with small hard stones, washed with a slip, and decorated free-hand. The black pottery is produced in a smothered fire which causes reduction. Illustrated. E.J.V.

Peasant potteries. ANON. *Pottery Gaz.*, **56** [644], 264–67 (1931).—Descriptions of small peasant operated potteries are given, processes described, and unusual products discussed. Illustrated. E.J.V.

Ancient glass history. ANON. *Nat. Glass Budget*, **46** [39], 23 (1931).—The finding of ancient glass near the Surrey-Sussex border is described. A description of the ware found is given and a history drawn from the various pieces. E.P.R.

Glass decanters. FRANK DAVIS. *Illus. London News*, **177**, 984 (1930).—Six photos of English and Irish glass are included. H.H.S.

The "Vanished People" of America. BRUCE BRYAN. *Discovery*, **12**, 3–6 (1931).—The finding of pottery sherds has provided the key to the ancient culture of the Southwestern U. S. H.H.S.

Priceless porcelain dug up in China. ANON. *Christian Sci. Mon.*, **23** [84], 5 (1931).—Thirty priceless porcelain objects believed to have been made at the famous Wu Sung kilns of the Sung dynasty have been discovered by archaeologists at Fengwang Mountain. E.J.V.

Chinese pottery dogs. ANON. *Sci. Amer.*, **144** [1], 45 (1931).—A photograph and discussion are given of an antique Chinese pottery dog in the Metropolitan Museum of Art. G.R.S.

Excavation of Verulamium (St. Albans). R. E. M. WHEELER. *Discovery*, **11**, 391 (1930).—Among the photographs is a mosaic floor in scallop-shell. H.H.S.

New light on ancient Syria. F. A. SCHAEFFER. *Illus. London News*, **177**, 968–72 (1930).—An unknown language has been deciphered from a dictionary of the 14th Century B.C., and a temple, royal tombs, and much pottery have been found. See also *Ceram. Abs.*, **9** [1], 13 (1930). H.H.S.

Guelph treasures for Ohio. ANON. *Illus. London News*, **177**, 982 (1930).—Six of the most important objects of the Guelph collection have been acquired by the Cleveland Museum of Art. Illustrated. H.H.S.

Chinese "old blue." ANON. *Christian Sci. Mon.*, **23** [10], 9 (1931).—Old blue and white Nanking porcelain still appeals. The choicest pieces of white porcelain in underglaze blue, of the reign of K'ang-Hsi, from 1662 A.D. to 1722 A.D., were made for the Imperial Court at Nanking at the imperial factory at King-te-Chen. The real Nanking can be distinguished by its greater hardness of body and glaze, its density, and the more complete fusing of glaze and body. E.J.V.

BOOKS

A Glass Master. ANDRÉ FERVENT. *L'Illustration*, Dec. 6, 1930. About $1.50.—André Hunebelle produces designs for glassware equal in beauty to the best creations of the Greeks, Persians, etc. (*D.I.*)

American Union of Decorative Artists and Craftsmen. R. L. LEONARD AND C. A. GLASSGOLD. Annual of American Design, 1931. Washburn, New York, 1931. $7.50.—This is a record of contemporary American designs in various industrial fields. Over 300 illustrations reproduce the work of leading designers. (*D.I.*)

A Dictionary of Color. A. MAERZ AND M. REA PAUL. *Jour. West. Soc. Eng.*, **36** [1], 56–57 (1931); for abstract see *Ceram. Abs.*, **10** [2], 95 (1931). W.W.M.

Revolt in the Arts. OLIVER M. SAYLER. Brentano's, New York, 1930. $3.50. A survey of the creation, distribution, and appreciation of art in America is given. (*D.I.*)

Clay Figurines of Babylonia and Assyria. E. D. VAN BUREN. 69 + 287 pp. 68 plates. Yale Univ. Press, New Haven, 1930. Price $6.50. Reviewed in *Times Lit. Supp.*, **29**, 1006 (1930). H.H.S.

Persian Art. INTERNATIONAL EXHIBITION OF PERSIAN ART. Luzac & Co., London. Cloth boards, 3s 6d. Reviewed in *Pottery Gaz.*, **56** [644], 272 (1931).—This book deals with various aspects of Persian art, including "Persian Art," by Roger Fry, "Early Persian Art," by C. J. Gadd, "Architecture," by K. A. C. Creswell, "Painting," by Laurence Binyon, "Pottery and Glass," by Bernard Rackham, "Textile Art," by Leigh Ashton, "Metal Work," by Leigh Ashton, and "Carpets," by C. E. C. Tattersall. Rackham says, "In the history of pottery of post-classical times Persia has played a part which, if less obviously recognizable at first glance, is hardly inferior to that of China." The book contains illustrations, many of which are in color. E.J.V.

Old Glass Beautiful. English and Irish. THOMAS ROHAN ("Pontil"). Mills & Boon, Ltd., London, 1930. 144 pp. 31 illustrations. Price 10s 6d. Reviewed in *Times Lit. Supp.*, **29**, 1088 (1930). H.H.S.

Archaeology of Roman Britain. R. G. COLLINGWOOD. xvi + 293 pp. Methuen & Co., London, 1930. Price 16s. Reviewed in *Times Lit. Supp.*, **29**, 1076 (1930).—C. interprets evidence taken from the transactions of learned societies. H.H.S.

PATENTS

Design for plate, etc. URASABURO TOMITA. U. S. 83,365 to 83,378, Feb. 17, 1931, and U. S. 83,479, Feb. 24, 1931; OTTO TAUSCHEK. U. S. 83,584, March 3, 1931; JOSEPH P. THORLEY. U. S. 83,294, Feb. 10, 1931.

Design for goblet. EDGAR M. BOTTOME. U. S. 83,388, Feb. 17, 1931, and U. S. 83,492 to 83,494, March 3, 1931; WILBER L. ORME. U. S. 83,412 and 83,413, Feb. 17, 1931.

Design for tumbler. JAMES M. PAYNE, JR. U. S. 83,290, Feb. 10, 1931; IRA H. FREESE AND DAVID C. EVANS. U. S. 83,320, Feb. 17, 1931.

Design for covered dish. JOSEPH P. THORLEY. U. S. 83,292, Feb. 10, 1931.

Design for cup. JOSEPH P. THORLEY. U. S. 83,293, Feb. 10, 1931.

Design for glass plate. GEORGE S. DUNBAR, ALBERT H. NICHOLSON, AND WILLIAM O. BARRY. U. S. 83,315, Feb. 17, 1931.

Design for candy jar. JAMES E. SPENCE. U. S. 83,359, Feb. 17, 1931.

Design for bathtub. LÉON V. SOLON. U. S. 83,416, Feb. 17, 1931.

Design for bottle, etc. WALTER D. TEAGUE. U. S. 83,417, Feb. 17, 1931.

Design for sheet glass. CONRAD J. GUNDLACH. U. S. 83,440 and 83,441, Feb. 24, 1931.

Design for ash tray. OSCAR E. BROWN. U. S. 83,495, March 3, 1931.

Design for water closet tank cover. HARRY FRANCIS WEAVER. U. S. 83,588, March 3, 1931.

Cement, Lime, and Plaster

Report of Committee C-1 on cement. ANON. *Proc. A.S.T.M.*, **30** [I], 417–36 (1930).—The committee has approved a revision of the Standard Specification for Portland cement involving an increase in the minimum tensile strength requirements for standard mortar briquets. It has prepared a set of tolerances concerning new and used cement-testing apparatus. Information supplied by manufacturers on the characteristics of masonry cements has been assembled. The activities of the Cement Testing Laboratory established by the A.S.T.M. through Committee C-1 at the Bur. of Standards have resulted in (1) the preparation of plans for carrying out the work, (2) securing and training an experienced personnel, (3) data on apparatus, test methods, and conditions in many laboratories, (4) reports of laboratory investigations, (5) elimination of some variations in test methods, (6) the improvement of condition of numerous pieces of apparatus, and (7) the accumulation of much information for compilation and study.

R.A.H.

Chemical-composition influence on manufacture and quality of cement. ALTON J. BLANK. *Rock Prod.*, **34** [2], 62–63 (1931).—B. presents some data based on monthly averages in a certain cement plant which show that as the Al_2O_3:Fe_2O_3 ratio drops from 2.75 to 1.30, the fuel consumption per barrel of clinker decreases while the output per kiln hour, specific gravity of clinker, per cent initially sound clinker from kilns, and tensile strength of cement produced increase. The alumina content of the cement is about 7%. Other examples of the effect of alumina content are shown and it is concluded that cements of high-alumina content are more difficult to clinker and to grind and are of poorer quality. The reasons for this are summarized.

W.W.M.

Influence of uncombined lime on cement. I. A. ALEXANDROFF. *Bldg. Materials*, No. 9–10, 5 pp. (1930).—A. describes researches made to ascertain the influence of uncombined lime on the volume stability of cement. The results are tabulated.

M.V.K.

Relation of free lime to constancy of volume. G. HAEGERMANN. *Zement*, **19**, 984–86 (1930); *Pit & Quarry*, **21** [9], 90 (1931).—In an investigation by H. as to the influence of free lime in Portland cement on the constancy of volume (soundness), 12 different raw mixes were clinkered under identical conditions at different calcining stages

from 1225 to 1475°C. The conclusion from an examination of the results is that, in the heating conditions prevalent in rotary kilns, a thorough calcination can be achieved at as low as 1275°. The clinkering stage for thorough calcination fluctuates, on the basis of resistance to the boiling test, for the different raw mixes by more than 200° and, on the basis of resistance to the cold-water tests, by about 100°C. The boiling test can be withstood with quantities of free lime up to 2% in the clinker. For resistance to the cold-water tests, 4% of free lime in the clinker is given as the upper limit. E.P.R.

Reactivity of lime and pozzuolana. G. MALQUORI AND F. PARISSI. *Giorn. chim. ind. applicata*, **12** [12], 597 (1930).—The reactivity test for determining the energy of pozzuolana is a quick and easy method of fixing the rapidity of reaction of pozzuolanous materials. See also *Ceram. Abs.*, **9** [11], 913 (1930). M.V.K.

Progress in the manufacture of hydraulic cements. EDMOND MARCOTTE. *Génie Civil*, **96**, 530 (1930). H.I.

Considerations of the index of hydraulicity of hydraulic binders. H. LAFUMA. *Rev. mat. constr. trav. pub.*, No. 238, pp. 241–46 (1929); *Rock Prod.*, **33** [19], 87 (1930).—In reviewing the results of his comprehensive theoretical considerations, L. states that it is possible under certain reservations to define for the silica-alumina-calcareous binders an index of capability to the hydraulic hardening and an index of chemical resistance exclusively based upon the chemical composition of the binders. The relation, $\frac{SiO_2 + 0.2Al_2O_3}{CaO}$, proposed wrongly by Vicat as the index of hydraulicity, is in reality an index of chemical resistance. The difference between these two indexes arises from the fact that the hydraulicity of a binder is a function of the composition of the anhydride compounds which constitute the binder; whereas the chemical resistance is a function of the hydrated compounds which constitute the hardened binders. It is necessary to take account of this difference in the definition of the two indexes. L. covers all hydraulic binding agents in this original treatment. See also *Ceram. Abs.*, **9** [9], 708 (1930). W.W.M.

Researches on hydration of Portland cement. I to V. KATSUZO KOYANAGI. *Jour. Soc. Chem. Ind.* [Japan], 147–53B (1930).—The results of tests show that by the hydration of a well-fired Portland cement the following hydration products originate: (1) thick, short needles and thin hexagonal plates consisting of calcium aluminate (the thick short needles change completely into the thin hexagonal plates with time); (2) thin, long needles consisting of calcium sulphoaluminate of the chemical composition $3CaO \cdot Al_2O_3 \cdot 2.5CaSO_4 \cdot 30H_2O$ appear only with an addition of gypsum; (3) a gel mass consisting of monocalcium silicate; and (4) large hexagonal crystals consisting of hydrate of lime. The hydration of a fired Portland cement begins with the formation of crystals of lime aluminate under any circumstances, or of calcium sulphoaluminate with an addition of gypsum. The separation of the jell mass of calcium hydrosilicate and of the large hexagonal crystals of hydrate of lime appears later. The setting of a well-fired Portland cement is brought about mainly by the formation of lime aluminate needles and plates. The retarding of the setting brought about by gypsum depends on the formation of calcium sulphoaluminates. The hardening process rests on the separation of a jell mass composed of calcium hydrosilicate. The hydration of a badly-fired clinker proceeds with a formation of jell. Only with a high-water addition does a weak formation of thick short needles of lime aluminates appear and much later, generally after several weeks, does a weak formation of hexagonal plates of lime aluminates appear. The setting and hardening of such clinker rest upon a separation of the jell mass. The former process is greatly shortened by the high heat of hydration of the uncombined lime, while the latter process is assisted by the weak formation of lime aluminate plates. M.V.K.

Tentative specifications for high early-strength Portland cement. A.S.T.M.

C74-30T. *Proc. A.S.T.M.*, **30** [I], 1016–18 (1930).—The chemical limits, fineness, soundness, time of setting, and tensile strength are given. R.A.H.

Upper SO_3 limit in Portland cement. F. O. ANDEREGG. *Rock Prod.*, **34** [5], 76–77 (1931).—A. tested four cements to which he had added various amounts of plaster of Paris. He concludes that the presence of more than 2.5% SO_3 in cements is undesirable. When sulphates react within calcium aluminate the aluminate increases about 200% in volume. The alumina content of clinker should be kept within reasonable limits. W.W.M.

Making iron separations in the analysis of Portland cement raw materials. T. G. LUDGATE. *Rock Prod.*, **34** [4], 58 (1931).—L. describes a quick and simple volumetric method for the determination of the iron content of cement raw materials. W.W.M.

Study of fourteen brands of standard Portland cements and four early-strength cements. C. H. SCHOLER AND L. H. KOENITZER. *Proc. A.S.T.M.*, **30** [II], 581–97 (1930). R.A.H.

Rate of hydration of cement clinker. II. Portland cement at 9 and 12 months. III. Three minerals found in Portland cement. F. O. ANDEREGG AND D. S. HUBBELL. *Proc. A.S.T.M.*, **30** [II], 572–80 (1930); for Part I see *Ceram. Abs.*, **9** [4], 256 (1930). R.A.H.

Action of kerosene on Portland cement. V. I. NAZAROFF. *Bldg. Materials*, No. 9–10, 6 pp. (1930).—The tensile strength of cement was lowered after storing in kerosene, which penetrates into cement. M.V.K.

Alumina cements. PIERRE BOYER. *Rev. mat. constr. trav. pub.*, No. 238 (1929); *Rock Prod.*, **32** [24], 110 (1929).—An abstract is given of the results of the researches of B. on the composition and chemical constitution of alumina cements as represented in full at the Congress of Industrial Chemistry at Paris, 1927. W.W.M.

Petrographic researches on alumina cement. KATSUZO KOYANAGI. *Jour. Soc. Chem. Ind.* [Japan], **33** [9], 352–58B (1930).—K. describes petrographic investigations on alumina cement which showed that one of the main constituents of alumina cement crystallizes in the form of a spherulite. The same crystal is found chiefly in the fusion of the compound $3CaO \cdot 2Al_2O_3$. M.V.K.

Valuation of alumina cement. HANS KÜHL. *Tonind.-Ztg.*, **55** [8], 111–12 (1931).—K. compares the qualities and properties of alumina cement with those of Portland cement. M.V.K.

Researches on rotary kiln in cement manufacture. XI. Calculation of the quantity of gases of combustion and air quantities required to make 1 lb. of clinker. GEOFFREY MARTIN. *Rock Prod.*, **34** [2], 60–61 (1931). **XII. Calculation of the specific heats of gases of combustion at high temperatures.** *Ibid.*, **34** [4], 54–55 (1931). **XIII. Calculation of the theoretical flame temperature of the rotary kiln.** *Ibid.*, **34** [5], 72–73 (1931); for Parts IX and X see *Ceram. Abs.*, **10** [3], 173 (1931). W.W.M.

Gypsum molds for interlocking tile. K. A. GOSLICH. *Tonind.-Ztg.*, **55** [10], 146–48 (1931).—G. discusses the kinds of gypsum suitable for molds for interlocking tile and describes their preparation. Illustrated. M.V.K.

Gypsum and gypsum products manufacture. VII. Retarders and accelerators and their action on plaster and stuccos. S. G. MCANALLY. *Rock Prod.*, **34** [4], 37–39 (1931); for part VI see *Ceram. Abs.*, **10** [3], 172 (1931). W.W.M.

Italy's rock products industry. R. DECKERT. *Rock Prod.*, **34** [4], 84–85 (1931); for abstract see *Ceram. Abs.*, **9** [12], 1021 (1930). W.W.M.

BOOKS

Cement. (Zement.) F. WECKE. Theodor Steinkopf, Dresden and Leipzig, 1930. Rm. 4.80. Reviewed in *Sprechsaal*, **64** [4], 77 (1931).—Progress in the cement

industry since the beginning of the century and the latest publications on raw materials and the separate processes in the production of cement are reviewed. M.V.K.

Three Swedish books on injury of cement by water. A. POULSEN. Reviewed in *Ingenioren*, **50**, pp. 595–98 (1930); *Tonind.-Ztg.*, **55** [8], 121 (1931).—The following books are reviewed: (1) Nils Sundius and G. Assarson, "The Change of the Chemical Capability of Resistance to Water of Portland Cement with Admixtures of Different Aggregates"; (2) Nils Sundius, "The Influence of Water Containing Carbonic Acid on Concrete"; and (3) Gunnar Assarson, "Influence of Lime Water on Aluminum." M.V.K.

PATENT

Making dental cement. JORGEN ERNST THOMSEN. U. S. 1,792,200, Feb. 10, 1931. The herein-described composition of matter in dry powder form suitable for use as a dental cement by the addition thereto of water alone, the composition consisting of approximately 145 parts by weight of a silicate cement and from 40 to 60 parts by weight of pure orthophosphoric acid or the equivalent of the acid in P_2O_5 radical, the ingredients being mixed together at a temperature sufficiently low to retain the mixture in an unstable condition capable of subsequently reacting with the added water to form a plastic mass capable of hardening.

Enamels

Acid-resisting enamels. A. I. ANDREWS. *Fuels & Fur.*, **8** [6], 863–64 (1930).—The acid-resisting enamels are less fusible, less fluid, and do not lay down easily. The silica content is greater and the fluorine compounds are present in smaller amounts than in ordinary enamels. The remaining constituents are balanced to take care of the fusibility, coefficient of expansion, and general working properties of the enamel. It has been found that a substitution of sodium silicate for the equivalent amount of soda ash and flint in the batch of some enamels greatly improves their acid resistance. The alkalis ($Na_2O + K_2O$) seldom exceed 18% of the melted weight as higher percentages tend to cause pinholing and a dull surface. Titanium oxide is used up to 8% in many acid-resisting enamels as it contributes about the same acid resistance as silica but gives a more fusible enamel. It does, however, give a cream color to the enamel. The fineness of grinding, application, and drying are unimportant factors from the standpoint of acid resistance. In most cases the higher the temperature and the longer the firing time, the greater the acid resistance. The acid resistance of dry-process cast iron enamels is not influenced by the firing time and temperature to any extent but the acid resistance of sheet steel enamels may or may not be affected. A.E.R.W.

Simple determination of mill-fineness of enamelware. E. MUSIOL. *Keram. Rund.*, **38**, 187–88 (1930).—For rapid plant control of mill-fineness the following method is recommended. A microscope object slide is cut into halves with a diamond and the thickness of each half is measured with a contact micrometer whose head is divided into hundredths of millimeters, the spot where each half is measured being marked. With a thin glass rod a small amount of the ground enamel is dropped on one-half of the slide and a drop of equal parts glycerin and alcohol is added. The other half of the slide is placed over the first and rubbed about until the enamel is distributed uniformly in the alcohol-glycerin and over the surface of the slide. The combination is then measured again with the micrometer, bringing the spots previously marked under the micrometer contacts. The difference between the last reading and the sum of the first two readings is a measure of the coarseness of the enamel. M. claims that the method has been used successfully for several years. See also *Ceram. Abs.*, **10** [2], 102 (1931). H.I.

Influence of carbon on the formation of bubbles and needle tappings in enameling cast iron. ANON. *Emaillewaren-Ind.*, **8** [2], 11–12 (1931).—Errors in enamels often necessitate a repetition of the enameling process which is difficult on cast-iron. The iron carbide is partly decomposed during a second firing of the enamel at high calcining temperatures of 830 to 860°, and graphite migrates to the surface of the cast. The changes taking place in iron during the separate phases of the enameling can be determined by using a metallographic microscope. It is seen that the ground mass of a raw unenameled pottery iron having 3.85% C, 2.24% Si, 0.61% Mn, 0.061% S, and 1.19% P is perlitic (dark) and contains graphite veins and nests. A phosphide eutectic is found between the perlitic places. A ground firing of 16 minutes at 860° causes a partial disintegration of the perlitic ground mass, around the graphite nests especially, and leaves the perlite and ferrite, near which appear the graphite and phosphide eutectics. After ground and enamel firing, ferrite forms the ground mass while perlite appears only in spots which are partly disintegrated. Under the microscope, iron with 3.60% C, 2.59% Si, 0.46% Mn, 0.067% S, and 0.77% P shows eutectic graphite in places. A raw unenameled iron with 3.55%C, 2.30% Si, 0.69% Mn, 0.058 S, and 0.80% P has many small embedded graphite leaflets. With the ground firing an almost complete disintegration of the perlitic constituent appears. One can see, therefore, that iron containing graphite in a finely-distributed or eutectic form, and not in nests, is generally resistant to fire; its structure is less altered by enameling, and such iron does not affect the enamel. The main reason for the formation of bubbles and needle tappings is the disintegration of the uncombined carbon during enameling. Casts which contain carbon in combined form, as a pure perlite cast, are best suited for enameling. M.V.K.

Applying ground coat wet-process enamels. ANON. *Better Enameling*, **2** [2], 12–15 (1931).—A ground or "grip" coat enamel is used in the enameling of all sheet-metal parts as this is necessary to get the proper adherence of the enamel to the metal. Some wet-process, cast-iron work requires the application of a ground coat but the majority of cast-iron enameling is accomplished by applying the finish-coat enamels directly to the casting. The equipment for dipping sheet-metal ware is listed and the method used for determining the proper consistency of the ground coat is given. W.C.O.W.

Microscopical investigation in enamel technique. FRITZ KRAGE AND VICTOR LINDT. *Sprechsaal*, **64** [1], 1–4 (1931).—The advantages of using microscopes for investigating enameled objects are pointed out. Errors in enameling and a relationship between the ground and second enamel coating and the iron can be easily detected. A description of samples investigated is given. Illustrated. M.V.K.

Measuring temperature in enamel kilns. VIELHABER. *Emaillewaren-Ind.*, **8** [7], 49–51 (1931).—The great influence of the temperature on the qualities, properties, and coloring of an enamel makes necessary exact temperature measurement in the muffle during fusing. M.V.K.

Blistering and pin heads on wet cast-iron enameling. WALTER KERSTAN. *Ceram. Ind.*, **16** [3], 254–56 (1931); for abstract see *Ceram. Abs.*, **10** [2], 102 (1931). W.W.M.

Inhibitor for pickling. ANON. *Chem. & Met. Eng.*, **38** [2], 107 (1931).—A new powdered material which when mixed with the acid prevents overpickling and loss of metal, may be supplied in two grades, foaming and nonfoaming. G.R.S.

Neutralizers in pickling process. ANON. *Ceram. Ind.*, **16** [3], 268 (1931).—The pickling process in preparing metal bases for enameling is described and the purposes of the neutralizer are given. W.W.M.

Pickling. FRED MCC. BURT. *Ceram. Ind.*, **16** [3], 276–77 (1931).—B. describes in detail the steps in modern pickling practice. W.W.M.

Preparation of sheet metal for enameling. WILHELM LINKE. *Emaillewaren-Ind.*, **8** [6], 41–43 (1931).—L. describes the preparation of fine sheet metal for enameling and

points out its importance. Good enameled ware can be manufactured only when the sheet metal used is of a definite composition and without any defects. An iron sheet may contain from 0.050 to 0.080% carbon, 0.230 to 0.350% manganese, and 0.002 to 0.080% phosphorus. Coefficient of solidity from 35 to 38%; coefficient of contraction from 56 to 65%; coefficient of expansion from 30 to 38%; specific gravity from 7.6 to 7.8. M.V.K.

Lining of enamel mills. JEMET. *Emaillewaren-Ind.*, **7** [52], 74–75 (1930); **8** [5], 2–3 (1931).—Lining enamel mills with porcelain, flint, or hard rubber is discussed and the disadvantages are shown. M.V.K.

Utilizing escaping heat in enamel factories. WILHELM LINKE. *Emaillewaren-Ind.*, **8** [4], 25–27 (1931).—The utilization of the great quantities of heat which escape unused in enamel factories because of irrational management is discussed. M.V.K.

Written specifications for processing in an enamel plant. ROY D. BECK. *Ceram. Ind.*, **16** [2], 151–72 (1931).—B. presents a system for processing instructions and specifications which has been in actual use in an enamel plant and offers it as a model for plants which have never used a system. See also *Ceram. Abs.*, **10** [3], 177 (1931). W.W.M.

Organization, equipping, and operation of a foundry laboratory. HENRY THYSSEN. *Rev. univ. Mines*, **3** [6], 157–62 (1930).—T. advocates the establishment of laboratories in connection with foundries and gives a description and plans of an ideal laboratory which was built by the Compagnie Général de Conduites d'Eau. Illustrated. L.T.B.

Colored aluminum widens competitive range against enamelware. ANON. *Ceram. Ind.*, **16** [2], 172 (1931).—By certain treatment, aluminum can be coated with its own oxide, giving any shade of gray. A variation in treatment results in a coating of strong affinity for certain organic dyes. Coatings of many colors and resistant to corrosion, abrasion, and cracking can be produced. An electrical "deplating" process is used to obtain the oxide coat. W.W.M.

Enameling steel elbows inside and out. ANON. *Ceram. Ind.*, **16** [2], 136–45 (1931).—The methods used in the plant of the American Valve & Enameling Corp. for the production of steel elbows enameled inside and out are described. The article is illustrated and a list of equipment used is included. W.W.M.

Enameling cast-iron bathtubs. VIELHABER. *Emaillewaren-Ind.*, **8** [2], 9–11; [3], 17–19; [4], 27–28; [5], 35–36 (1931).—V. describes the preparation and enameling of cast-iron bathtubs. Before enameling, the cast iron must be analyzed to determine its silicon and sulphur content in order to ascertain the expansion of the cast and to prepare a suitable enamel. The composition of the thin ground-coat enamel and of several batches of powder enamel for the second coat are given with directions for preparing, testing, and applying.

Enameling large castings. ANON. *Ceram. Ind.*, **16** [2], 146–47 (1931).—Iron castings as large as 60-in. sinks are enameled in the D. A. Ebinger Sanitary Mfg. Co.'s plant, at Columbus, Ohio. Illustrated. W.W.M.

Enameled tanks and their manufacture. ANON. *Emaillewaren-Ind.*, **8** [5], 1 (1931).—A description of the manufacture of enameled steel tanks used for keeping wine, fruit juice, cider, chemical products, and fermenting liquids is given. M.V.K.

PATENTS

Apparatus for enameling articles. JOHN C. CROMWELL. U. S. 1,792,284, Feb. 10, 1931. A heat-treating furnace, comprising three heat-treating chambers in lateral offset relationship, and means common to all of the chambers and extending through the roof portions thereof for carrying an article successively therethrough is described.

Muffle furnace for enamel work. GEORG TIEGEL. Ger. 507,859, April 11, 1929. The construction of the furnace from ceramic plates and steel of high heat-resisting capacity is described. (*C.A.*)

Enameling iron. ALEXANDER KREIDL. Ger. 509,381, Oct. 28, 1925. The viscosity of the fused enamel is raised by adding carbonates or other water-insoluble compounds of the alkaline earths and by raising the Al content. The enamel can then be applied at a high temperature, *e.g.*, 950°, while still using only about 6% of the opacifying agent (SnO_2). (*C.A.*)

Glass

Influence of different radiations on the coloring of glasses. P. GILARD AND A. LECRENIER. *Chim. & ind.*, **24** [5], 1035–51 (1930); *Sprechsaal*, **64** [5], 94 (1931); *Rev. univ. Mines*, **4** [12], 349–62 (1930).—The action of ultra-violet (mercury vapor lamp) and radioactive (Ra-radiation) rays of 100 glasses of different composition was studied. It is impossible to say whether the coloring of glasses is caused by chemical or physical changes. In many cases, as in the violet coloring of glasses containing Mn exposed to rays, the coloring can be easily explained by chemical processes (although, here also disproportionately intensive colorings in glasses with a very small Mn content were determined), in other cases the coloring must be ascribed to other reasons and not to chemical changes in the structure, *i.e.*, pure fused silicic acid or quartz glass, which is completely free from admixtures, takes up a violet color when exposed to rays. This is brought about by physical changes only. Fifteen glasses were treated with ultra-violet rays; an effect of rays contrary to the decolorizing process in glasses (a dissociating action on ferric compounds) was determined. The ferric form changes into ferrous form and the free oxygen oxidizes the manganous compounds into manganic compounds which color the glass violet. Soda-lime glasses decolorized with Se were not changed by exposure to rays; a fact showing the suitability of this kind of glass for use in hot countries. All colorings again disappear when the glasses are heated to their softening point. Radioactive rays act more intensely in coloring glass. On the basis of investigations on glasses of varied composition, the following results were ascertained: Soda glasses are colored into brownish by radium rays and the nuance of the color depends more on the nature of the oxides of alkaline-earth present than on the alkali content. The same was determined for potassium glasses, except that the colors are more yellow. Mixtures of alkalis act additively; the colors become dirty brown. Lime strengthens the brown coloring in soda glasses and gives potassium glasses a brownish tinge. Barium oxide colors potassium glasses into greenish, and soda glasses into yellow-brownish, but has no great influence. Magnesium oxide acts as lime. The simultaneous presence of CaO and BaO in glasses gives soda glasses a greenish-brown coloring, in potassium glasses it gives a brownish-green coloring. A content of boron oxide (B_2O_3) imparts to soda glasses a brownish-gray coloring, which easily increases with the increase of the boron content and gives the glasses a smoky appearance; potassium glasses are colored into bluish-gray. The following table shows the influence of Ra-rays on glasses containing coloring oxides.

Glasses		Coloring (Before exposure)	(After exposure)
$6SiO_2 \cdot CaO \cdot Na_2O$	+Ni	Amethyst-violet	Blue-brown
	+Co	Violet-blue	Sky blue
	+Cr	Green	Brown-green
	+Cu	Blue-green	Without change
	+Mn	White-pink	Violet
	+Fe	Pale green	Without change

Glasses		Coloring (Before exposure)	(After exposure)
$6SiO_2 \cdot CaO \cdot K_2O$	+Ni	Violet	Dark brown
	+Co	Violet-blue	Sky blue
	+Cr	Green	Some darker
	+Cu	Blue-green	Without change
	+Mn	Violet	" "
	+Fe	Pale green	" "
$6SiO_2 \cdot BaO \cdot Na_2O$	+Ni	Violet	Blue-brown
	+Co	Violet-blue	Sky blue
	+Cr	Green	Brown-green
	+Cu	Blue-green	Without change
	+Fe	Pale green	" "
$6SiO_2 \cdot BaO \cdot K_2O$	+Ni	Violet	Amethyst-brown
	+Co	Blue (some violet)	Purer blue
	+Cr	Green	Olive green
	+Cu	Blue-green	Without change
	+Mn	Violet	Brown-violet
	+Fe	Yellow-green	Without change
$6SiO_2 \cdot ZnO \cdot Na_2O$	+Cr	Green	Without change
	+Co	Violet-blue	Sky blue
	+Fe	Light green	Without change
$6SiO_2 \cdot ZnO \cdot K_2O$	+Cr	Olive-green	Dark olive green
	+Co	Violet-blue	Sky blue

Glasses containing Cu and Fe seem not to be colored. The authors discuss in detail the coloring but do not give a conclusive opinion. M.V.K.

Electrical conductivity of glasses. System B_2O_3–Na_2O. S. A. SCHTSCHUKAREFF AND R. L. MULLER. *Z. phys. Chem.*, **150** [5], 439–75 (1930).—B_2O_3 glasses were chosen for the study because of the ease with which they were made. A series of glasses were made in the system B_2O_3 + Na_2O in which the Na_2O content varied from 0.01% to 32%. Molten borax showed a relatively high conductivity so that it was concluded that this compound in the solid state must have an ionic structure. Glasses low in Na_2O may be considered as a solution of Na ions in complex boric acid ions in an excess of boric anhydride. The character of the conduction is ionic in which only the cations are in motion, while the anions are practically immobile. The complexity of the boric anions B_4O_7'' (or maybe B_8O_{13}'') is the cause of their immobility. That the conductivity of the glass is due solely to the cations was shown by the enrichment of the mercury cathode used in sodium. The percentage of the total Na which takes part in the conductivity at any moment is very small and amounts to only 0.2%. Due to the viscosity of the glass the mobility of these ions is very small. In these glasses the conductivity curves rise as the Na concentration increases. In aqueous solutions the conductivity decreases as the concentration increases. On increasing the Na concentration of the glass ten times the equivalent conductivity increased by a factor of a million (from 10^{-10} to 10^{-4} at 250°C). The conductivity-concentration curve rises slowly at first till a certain amount of Na is present; then with an increase of Na there is a break in the conductivity and a definite sharp increase. This break occurs in that region of concentration which is designated as the boundary at which crystallization begins. The specific conductivity does not change from one specimen to another of the same composition, and after eight months the results are reproducible. Complete tables of measurements on the various glasses are included in the article. L.T.B.

Variations caused in the heating curves of glass by heat treatment. A. Q. TOOL AND C. G. EICHLIN. *Jour. Amer. Ceram. Soc.*, **14** [4], 276–308 (1931).

Analytical valuation of complex chemical and induced reactions. F. FEIGL AND P. KRUMHOLZ. *Sprechsaal*, **64** [5], 91 (1931).—A sensitive method is given for detecting

silicic acid when investigating the ease with which different kinds of glass can be affected. One cc. of the weak nitric or hydrochloric acid solution to be investigated (the acidity must not exceed normal 5 or normal 2) is treated with 2 drops of an ammonium molybdate solution, combined with nitric acid, and heated to the boiling point. It is cooled and 1 or 2 drops of an 0.25% benzidine (benzidinechlorhydrate) solution in 10% acetic acid with an equal volume of saturated sodium acetate solution are added. The silicic acid present appears in the form of a blue sediment or a blue coloring. When only a small quantity of silicic acid is present, the detection can be made more sensitive by shaking with amyl alcohol, and a blue, easily recognizable film is obtained on the parting plane of the alcohol water. 0.4μ g. in 1 cc. of a solution is detectable which corresponds to a sensitiveness of 1:2,500,000. A blank test must be made in a test tube of Jenaer glass before the investigation because of the sensitiveness of the reaction (ordinary glass reacts after 30 seconds boiling with water). In order to detect silicic acid in the presence of P_2O_5, the soluble silicomolybdic acid is filtered from the insoluble $(NH_4)_3PO_4 \cdot 12MoO_3$, and the traces of phosphorous molybdate which are passed through the filter are decomposed with oxalic acid. One cc. of the solution is treated with ammonium molybdate in excess, heated to boiling, and the insoluble phosphorous molybdate is filtered off, tested until completely precipitated, and treated with several drops of saturated oxalic acid. The above-mentioned procedure is then performed. In order to detect silicic acid in a solid substance, the sample is pulverized, a part of it is fused with alkali carbonate on a platinum wire, the pearl is dissolved in dilute HNO_3, and then treated as above. The determination of silicic acid can also be used for detecting small quantities of fluorine. According to the conversion: $4HF + SiO_2 = SiF_4 + 2H_2O$, $3SiF_4 + 4H_2O = Si(OH)_4 + 2H_2SiF_6$ silicic acid is obtained. The sample is disintegrated with H_2SO_4 in the usual way. It is concentrated over a small flame in a vessel covered with a moistened watch glass until the appearance of sulphuric acid vapors, left to stand for several minutes, then the watch glass is rinsed with water in a Jenaer tube. The procedure described above is applied for determining the silicic acid formed. M.V.K.

Reactions on melting glass compositions. G. TAMMANN AND W. OELSEN. *Z. anorg. allgem. Chem.*, **193** [3], 245–69 (1930).—(1) *Soda glass.* On heating a soda glass composition there is formed, first of all, a double carbonate $CaNa_2(CO_3)_2$. This reaction begins at 600°C and is therefore in the solid state. The formation of this compound is accompanied by the evolution of CO_2; reaction with the SiO_2 also begins at the same temperature. As the temperature is raised there occurs the melting of the eutectic of Na_2CO_3 and $CaNa_2(CO_3)_2$. At the same time the SiO_2 reacts more vigorously until all the Na_2O has entered into combination; then the CaO begins to react with the SiO_2. In this way the mixture changes to a homogeneous fluid. (2) *Lead glass.* On heating lead glass compositions, oxygen is evolved first of all from the red lead. The reaction of the solid PbO with the SiO_2 which begins at 700°C follows. At slightly higher temperatures the free SiO_2 which still remains, begins to react with the K_2CO_3. The excess lead oxide melts at 835°C, while the excess K_2CO_3 becomes liquid at 894°C. These two liquids do not mix but remain as separate phases. The excess K_2CO_3 dissolves in the eutectic mixture of the lead silicates which melts at 675°C. (3) *Sulphate glass.* On heating sulphate glass compositions, water is given off between 100°C and 130°C. At about 620°C CO_2 is evolved. Between 740°C and 900°C there are complicated reactions and heating curves show many breaks which are due to eutectic formation, reduction of Na_2SO_4 to Na_2S, and to the reaction of the constituents to form intermediate products. At least twelve such intermediate products are known and the reactions by which they are formed are given in some detail. Above 900°C the reactions of the Na_2SO_4 and $CaSO_4$ with the SiO_2 are completed and at 1240°C the composition becomes clear. If there is insufficient reduction of the sulphate to Na_2S then at 1400°C the lighter liquid

Na_2SO_4 may float on the heavier silicate melt. Due to the relative slow solubility of the Na_2SO_4 in the melt, it reacts only with the silicate at the surface of contact. This separation of the two phases is not due to the immiscibility of the Na_2SiO_3 and the Na_2SO_4 for they are miscible in all proportions as is shown in the binary diagrams of the two compounds, which diagrams are included. If excess SiO_2 is added to the mixture of those two compounds there is only partial solubility at 1100°C. Diagrams of systems higher than SiO_2 are given. To prevent any separation of phases, the Na_2SO_4 should be reduced to Na_2S; this may be accomplished by the addition of a reducing agent to the melt. Powdered coal may be used to effect this reduction. L.T.B.

Decomposing glass with superheated steam. F. H. ZSCHACKE. *Chem.-Ztg.*, **55** [4], 41 (1931).—Glasses with a high alkali content are corroded by water. This action of the water increases with the increase in temperature and pressure and leads to complete disintegration of the glass body. Even the mineralization of glass was observed. The hydrolitic properties of glass were investigated in an autoclave. On opening the autoclave no water was found or only traces of it in the form of a highly-concentrated alkali hydroxide solution. When heated, the water may be separated and the glass swells and forms a foamy, voluminous, white mass. In general there is no glass immune to the action of moisture. Even in highly-resistant glass the appearance of the so-called water skin can be observed. Owing to an adsorption of gases and humidity, the surface of the glass suffers a penetrating chemical change caused by swelling phenomena and diffusion processes. In glass of good quality these processes are limited to the surface layer only, while in glasses of lower quality these chemical processes consisting of hydrolysis of silicates and a hydration of hydrolyzed constituents extend to the interior of the glass and cause disintegration. As the alkali silicates are more easily hydrolytically split and hydrated, glass with a high alkali content is more subject to disintegration. Calcium silicates are not affected by water and therefore their presence makes the glass more stable. The substitution of alkalis by calcium silicates is limited as the glass becomes very difficult to fuse and devitrifies easily during working if a certain quantity is exceeded. By substituting silicic acid for alkalis, the stability of glass is increased greatly, but with such glasses the working difficulties are as great as with glasses containing lime. Only by introducing other oxides in the glass can glasses be obtained which are practically unaffected by water. Alumina introduced in quantities amounting to 3 to 8% greatly increases glass stability and decreases the danger of devitrification, but such glasses are difficult to fuse. Boric acid, in the same quantities, lowers the fusing and working temperatures of the glass and increases its resistance to heat and the action of water. With higher concentrations of boric acid, this resistance diminishes. With the introduction of both oxides, glasses are obtained which satisfy all requirements of chemistry. The composition of glasses for firing pipes, resistance glass, and hard apparatus glass is given. M.V.K.

Decolorization of glasses. GEORG JAECKEL. *Glastech. Ber.*, **8** [5], 257–85 (1930); *Diamant*, **51** [35], 683 (1929); for abstract see *Ceram Abs.*, **10** [2], 105 (1931). E.J.V.

Theory of the composition of glass. E. ZSCHIMMER. *Jour. Soc. Glass Tech.*, **14** [55], 229–49 (1930).—Emphasis is placed on the importance of constant composition of the glass and not of the batch. In a well-organized factory no batch would be kept constant. Allowance must be made for moisture and other volatile impurities in the raw materials. Graphs are given which simplify calculations of synthetic compositions of glass. The form in which the relation of chemical composition to properties may best be shown, is discussed. Some methods used are (1) those employing molecular calculation and (2) those based on parts by weight. The graphical method of presenting the relationship between physical properties and chemical composition is dealt with in de-

tail, numerous diagrams being given. The method of working out four component glasses is taken up using examples from the fundamental systems of the glass industry: (1) lime crystal group, silica, soda, lime; (2) lead oxide crystal group, silica, potash, lead oxide; and (3) resistant group, silica, boric oxide, soda. See also *Ceram. Abs.*, **9** [10], 833 (1930). G.R.S.

Dependence of the properties of glass on its thermal history. E. BERGER. *Jour. Soc. Glass Tech.*, **14** [55], 280–94 (1930).—By the dependence of the properties of glass on its thermal history is meant the manner in which they vary with the conditions of cooling. Density, expansion, and many other properties are affected by the manner of cooling. Double refraction arises in glass because, owing to unequal cooling down, states of aggregation differing from each other are produced inside and on the surface. The annealing process effects release from strain by levelling out the physico-chemical inequalities of the piece of glass to a final state. Viscosity plays no part, directly at least, in the whole process. G.R.S.

Experiments on the cascade method of melting glass. T. C. MOORSHEAD AND E. A. COAD-PRYOR. *Jour. Soc. Glass Tech.*, **14** [55], 249–62 (1930).—Batch-free glass was made by feeding finely-powdered hot batch into the flame of a special furnace. The batch on entering the furnace was caught in the swirl of the flame and at once thrown onto the wall of the furnace. It trickled down the furnace, taking about half an hour to travel 10 ft. Inspection of the lining of the furnace after it had been running for a few weeks showed that there was no sign of local erosion. A series of experiments was carried out to determine to what extent a soda-lime batch could be preheated without becoming unmanageable in the feeding machinery. At 820°C the batch began to show signs of stickiness. Diagrams are shown of the arrangement of the batch sintering machine. The preheated batch is fed to a tank of the orthodox type. It is anticipated that such a plant will operate at approximately 60% efficiency, and by utilizing the waste gases for a portion of the heating, 20 tons of batch can be heated per ton of oil. G.R.S.

The glass melt—homogeneity. S. R. SCHOLES. *Fuels & Fur.*, **8** [11], 1557–58 (1930).—S. gives diagrams to show the composition of four types of glasses: bottle, window, goblet, and oven. He points out that silica forms 70% of all glass made. The steps taken to secure homogeneity in the glass are given. In mixing, the raw materials should all be of approximately the same grade of fineness. The exceptions are burned and hydrated lime which are mainly powders. The problem of mixing is not so significant where a single batch goes into one pot as it is where tanks are used. One reason for this is that a closed glass pot possesses the property of setting up a convection current in the glass, and thus the heavier and lighter silicates are mixed. In tanks, this movement is less evident. Striae and stones are two defects which frequently arise in the glass. A.E.R.W.

Effect of remelting on the properties of glass. W. E. S. TURNER. *Fuels & Fur.*, **8** [12], 1659–60 (1930); for abstract see *Ceram. Abs.*, **10** [2], 107 (1931). A.E.R.W.

Index of refraction of some soda-lime glasses as a function of their composition. ANON. Bur. Stand., *Tech. News Bull.*, No. 166, pp. 16–17 (1931).—The index of refraction of all soda-lime glasses studied can be expressed by the following equation: $N - 1 = aA + bB + cC$ in which A, B, and C are the percentages of silica, soda, and lime, respectively; a, b, and c are the corresponding constants which are different for different ranges of silica as follows:

Silica range (in %)	(a)	(b)	(c)
50–59.5	0.004836	0.005491	0.007521
59.5–73.75	0.004785	0.005568	0.007598
73.75–100	0.004584	0.006127	0.007977

R.A.H.

Molecular kinetics in the softening range of glasses. G. TAMMANN. *Z. anorg. allgem. Chem.*, **193** [4], 406–408 (1930).—In the softening range of glasses the specific heat and the coefficient of expansion increase with the temperature; for glasses which soften between 0° and 100°C these increases are complete in a temperature interval of 2 to 12°. It has been asserted that these changes are due to polymerization. Polymerization is only characteristic of such materials which have a definite composition. The solidification of a highly viscous liquid to a glass is a reversible process, while polymerization reactions which are reversible in a small temperature range have not yet been observed. Furthermore, the tendency to polymerize is influenced greatly by the presence of foreign materials while the changes in the specific heats and in the coefficient of expansion occur in chemically pure substances as well as in binary mixtures. In the short temperature interval in which these changes in the specific heat and coefficient of expansion take place, the volume changes by only a small amount; therefore the mean interatomic spacings are changed by only a small amount. The increase of $\frac{dv}{dt}$ in the softening range is not due to an increase in the amplitude of vibration of the atoms but must be due to other changes in their motion. In the glassy state the molecule does not yet exist and the addition of heat only causes an increase of the vibrational energy of the atoms. The softening interval may be looked upon as the "temperature of birth" of the molecule from its constituent atoms. We may assume that at the temperature at which glasses begin to soften the first molecules begin to rotate and by the time the softening interval has been passed all molecules are rotating and the glass has the properties of a liquid. It is in this temperature interval that the molecules are sufficiently separated to allow them to rotate. The heat content of a crystal is only slightly less than that of a glass at the same temperature, and only from the softening interval does this difference increase proportionately to the temperature. This difference is practically equal to the increase of the rotational energy. The reason the molecules only begin to rotate in the softening interval may be pictured in the following manner: At low temperatures the molecules are in close contact and there exists between them a field of force which prevents their rotation. On increasing the energy content by heating, the increase becomes evident as an increase in the vibrational energy. Therefore the specific heats of a crystal and a glass at the same temperature are practically the same and only in the softening range when the rotational energy becomes evident does the specific heat between the two states differ by an appreciable amount. L.T.B.

Calculating the coefficient of thermal expansion of glasses in relation to their chemical composition. N. SOLOMIN. *Ceramics & Glass*, **6** [11–12], 519–21 (1930).—S. discusses and calculates the coefficient of thermal expansion of glasses, in dependence on their chemical composition, and on the bases of the constants of Schott and Winkelmann, and English and Turner. M.V.K.

Opaque efflorescences on glass during firing. M. F. SHUR AND N. N. VESSELKOVA. *Ceramics & Glass* [Supp.], **6** [7–8], 16–17 (1930).—The reasons for the appearance of opaque efflorescences on glass objects during firing are discussed and tests made are described. Some efflorescences could be washed off with distilled water and analyzed. The reason for the appearance of efflorescences must be ascribed to the flue gases containing carbonic acid and sulphurous compounds which react with soda, potassium, calcium, and lead present in the glass to form compounds. Efflorescences which could not be washed off were analyzed by microscope. Illustrated. M.V.K.

Scientific and technical progress in the field of optical glass. E. BERGER. *Z. Instr.*, **50**, 155–60 (1930).—Improvements in optical glass in the near future probably will take the form of introduction of new oxides into the batch or a more detailed investigation of the composition systems now used. A detailed study of the optical and

other physical properties of glass in the system soda–potash–lime–alumina–silica will give valuable results. Development of new types of colored glasses with careful measurement of transmissivities of these and older types should be made. Development of white, homogeneous, and workable glass for optical pieces of large size is imperative. A change in the theory of the glassy condition has been apparent for some time. The old belief that the properties of a glass may be found by a continuous extrapolation to room temperature of the properties of a liquid of the same composition at higher temperatures is no longer tenable. Curves of all the properties show a break at a fairly definite transition temperature. To the three accepted states of matter a new state, the amorphous solid state, must be added. This conception of the glassy state may lead to improvements in the weather resistance of glass. H.I.

Manufacture of photographic lenses. ROBERT S. GUILFORD. *Glass Ind.*, **12** [2], 23–27 (1931).—The most important change is the almost exclusive use of molded lenses resulting from greater precision in annealing. Another change is that each operator performs a comparatively simple operation on a large number of lenses. The first requirement of a lens plant is a computing department, engineering department, and a process department that can lay out a series of economical processes. The specifications for the glass used are enumerated. Some of the conditions met by lenses in actual use are discussed. The processes used in making lenses are traced through the making of rough disks out of cubes of optical glass, the annealing to remove strains, inspection for defects, rough-grinding, finish grinding, and finally polishing, which is divided into two types, wax polishing and felt polishing. After polishing, the lenses must be handled carefully and cleaned before the edge grinding is done. Innumerable inspections must be met through the many processes until the lenses have passed the final inspection and are ready for assembly into mounts. Tests used on the assembled lenses are discussed. Illustrated. E.J.V.

Optical properties of didymium glass. E. J. MOORE, H. S. LEIN, AND D. E. SHARP. *Glass Ind.*, **12** [3], 49–51 (1931).—If a glass could be made in which the refractive index and dispersion did not vary in the same direction with change in color of the light, it would result in new designs of lens systems of great utility. This phenomenon is called anomalous dispersion. As it seemed reasonable to suppose that if a glass could be made having a sharp absorption band in the visible, that glass would exhibit anomalous dispersion. A study was made of a glass containing didymium, as that is the only material that was known to produce a fairly sharp absorption band in glass. The glass studied was: SiO_2, 49.5%; K_2O, 14.0%; Na_2O, 6.0%; B_2O_3, 20.5%; didymium oxide, 10.0%. Three methods employed in attacking the problem were as follows: (1) A dispersion curve was obtained by measurements of refractive indices of a 60° prism of didymium glass using an accurate spectrometer. (2) Another series of measurements of refractive index was made on a 30° prism by the use of an Abbé auto-collimating spectrometer; (3) the method of crossed prisms was used as a check. Results showed that if any anomalous dispersion is present in this glass, it is too small in amount to be determined by the means employed. One interesting property of the didymium glass, probably never before noted, is the high constringence or value of μ. The data on indices of refraction determined is presented in tables. E.J.V.

Technical light-transmitting building materials. E. SUMMERER. *Electrotech.-Z.*, **51** [43], 1483–86 (1930).—Measurements of optical reflection, transmission, and absorption were made on clear, ornamental, ground, and opal glasses, on marble, alabaster, paper, and various fibers. M.A.E.

Investigations on bottle glasses. GUSTAV KEPPELER. *Glastech. Ber.*, **8** [2], 65–84 (1930); *Diamant*, **51** [36], 705–706 (1929).—In this investigation a great number of different bottle glasses were studied and analyzed. A comparison with earlier pro-

ductions and the modern English and American products showed that there is a series of bottle glass types that can be used. The compositions of the various glasses were simplified into four component types by dividing the constituents as follows: SiO_2; Al_2O_3 and Fe_2O_3 as R_2O_3; MnO, CaO, and MgO as RO; and K_2O and Na_2O as R_2O. An average of the 28 glasses used in the bottle plants in Germany gave the composition on this basis of SiO_2, 64.00%; R_2O_3, 8.80%; RO, 15.50%, and R_2O, 11.70%, from which the individual glasses vary by 2 to 3%. In contrast thereto the new English-American product is characterized by a lower alumina and lime content and a much higher alkali content. Accordingly these glasses are considerably softer than the German Owens glasses. These glasses possess important advantages for bottle production, especially by the mechanical means. The investigations showed that the German Owens type glasses belong to the first and second hydrolytic classes due to their chemical stability and approach the best apparatus glasses for chemical work. Results of absorption-spectrum investigations are also cited. E.J.V.

Stability of bottle glass. G. KEPPELER AND RICHARD MAENICKE. *Sprechsaal*, **64** [1], 7–10; [2], 28–30; [3], 46–49; [4], 65–68 (1931).—Beer bottles were investigated and their solubility determined. Their composition was reproduced on four-dimensional and triangular diagrams to find the relation between their real solubility and that solubility which appears on the basis of the schematic composition with the help of material dissolved from pure mixtures of Na–CaO–SiO_2 system. Several kinds of beer were investigated to ascertain the influence of glass on the stability of beer. It was found that beer with a high content of albumin becomes more turbid than beer poor in albumin. An albumin content greater than 0.6% seems to promote turbidity. Brown glass must be used to keep the beer clear as this color absorbs the short waves of light which accelerate the separation into flakes. M.V.K.

Bottle glass batches with nepheline cyanites. A. H. DAUVALTER AND N. D. ZAVIALOV. *Ceramics & Glass*, **6** [11–12], 504–506 (1930).—Several batches containing nepheline cyanites for the preparation of bottle glass are given. M.V.K.

Stony glass. LUDWIG SPRINGER. *Sprechsaal*, **64** [7], 129–32 (1931).—S. continued his investigations on stony glass and describes his researches on stones artificially produced in different glass batches. Illustrated. For previous abstract see *Ceram. Abs.*, **9** [9], 725 (1930). M.V.K.

Invisible ray glasses. S. ENGLISH. *Elec. Rev.*, **108** [2773], 126–27 (1931).—Wherever visible radiation is produced, invisible rays are produced at the same time. It is necessary, therefore, to know something about glasses for transmitting and for absorbing such rays. Invisible infra-red and ultra-violet rays are produced by exactly the same type of ether waves as produce visible light. The only essential difference is in their wave lengths. Only a small range of wave lengths is occupied by light-producing rays. The ultra-violet rays are characterized by their strong chemical and biological activity, and a certain small band of them is very important in promoting good health, but only a very narrow band lying quite near to the limit of the sun's spectrum and extending only from about 295μ to 320μ. The band has become known as the health rays. The ideal material for transmitting these rays is clear silica. Although ordinary glass generally consists of 70 to 75% silica, its ultra-violet transmission is not comparable with that of pure silica. The two constituents which are most favorable to ultra-violet transmission are silica and boric oxide; the two most dangerous constituents are iron oxide and titania. In all ultra-violet glasses the iron oxide content should be below 0.02%; as it increases from 0.005 to 1.01% the limit of ultra-violet transparency changes from about 250μ to 325μ. When iron is present in a glass in the reduced or ferrous condition it is much less dangerous than when present in the ferric condition. At present all ultra-violet transparent glasses are melted under reducing conditions and reducing agents

are usually included in the batch mixture. Several promising glasses have been produced of fairly satisfactory transparencies to the invisible health rays to which ordinary glasses are opaque. The best commercial glasses at 310 have a transmission of about 73%. The advantage in favor of boric oxide needs careful using for if it is pressed too far, numerous manufacturing difficulties arise that render the glass bad in every respect but ultra-violet transparency. Wood's glass, which is opaque to the visible rays but transmits the invisible ultra-violet rays, owes its peculiar properties to the fact that it contains a proportion of nickel oxide on a potash base, sufficient to color the glass deep blue and thus obstruct the passage of visible light. The best way of showing the presence of ultra-violet rays is by using substances that convert short wave-length rays so as to extend them into the range of visible rays. One such means is a fluorescein solution in a silica vessel. "Canary" glass, a greenish-yellow color and containing as small a proportion as 1% of uranium oxide on a soda-lime base, is strongly fluorescent. Wood's glass has proved to be valuable in research, for quite a number of things can be picked out under the influence of ultra-violet rays in the absence of visible light. E.P.R.

Ultra-violet window glazing. H. E. BECKET. Dept. Sci. Ind. Research, Bldg. Research, *Bull.*, No. 8 (1930).—The discovery of the therapeutic value of ultra-violet rays has encouraged the development of special window glasses for the transmission of these rays. The most efficient vitreous medium for ultra-violet transmission is pure fused quartz, which in a thickness of 4.7 mm. transmits 92% of normally incident radiation to as low a wave-length as 0.26μ. Another glass which consists almost entirely of fused calcium phosphate and, in a thickness of 2.86 mm., transmits 85% of normally incident radiation to a wave-length of 0.29μ, has been tested. This material is of little value for windows as it is easily scratched and suffers rapid corrosion in a moist atmosphere. The glasses which are generally used do not differ markedly in composition from ordinary window glass except in the inclusion of boric oxide. Certain impurities, however, especially iron oxide, must be excluded. Manufacturing difficulties have largely been solved and glass of good quality is now obtainable. A serious decrease in ultra-violet transmission always accompanies an increase in thickness of the glass, so the use of thick glass should be avoided. Some glasses have a tendency to become less transparent on exposure to sunshine. This is attributed to the presence of ferrous oxide in the glass, which on exposure to ultra-violet radiation is oxidized to ferric oxide with a consequent decrease in transparency. Greater precaution in the elimination of iron contamination has resulted in increased stability. When glass is exposed to a damp and dirty atmosphere for long periods without cleaning, a considerable reduction in its transmission results. W.L.

Ultra-violet lamp and its use. AXMANN. *Electrotech. Z.*, **51** [44], 1514–15 (1930).—A description is given of the "Osram-Vitalux" metal filament lamp with ultra-violet transmitting glass, together with its therapeutic uses. M.A.E.

Modern methods of cleaning carbon from glass molds. WM. M. PARKIN. *Nat. Glass Budget*, **46** [43], 3 (1931).—The new and economical method of removing this carbon is by subjecting the mold to two chemical reactions which will completely remove the carbon without injurious results to the surface and prolong the life of the mold. (1) The oil, both free, combined, and that which is embodied in the grain structure of the carbonaceous material, is removed by changing the oil to an emulsion and allowing it to float off on the surface. (2) Immersion in an acid solution breaks down the carbon and removes it entirely from the surface. The most important factor in the success or failure of this second step is that the acid must be "doctored" by a compound which is covered by basic patents as to process and chemical structure. This chemical compound is called an "inhibitor." The process is described in detail. E.P.R.

Term "pounds of glass per pound of coal." JOHN W. ROMIG. *Glass Ind.*, **12** [2],

28–29 (1931).—The much discussed term "pounds of glass per pound of fuel" or the opposite, "pounds of fuel per pound of glass" has no particular significance unless some other factors are given consideration. Factors that must be considered when discussing melting efficiency on the basis of glass melted in tanks are (1) furnace construction and capacity, (2) regenerative capacity, (3) temperature in tank, (4) quality of fuel, and (5) pull on the tank. The effect of each of these factors is pointed out in a detailed discussion. Illustrated. E.J.V.

Manufacture of rolled plate. V. ERNST LUTZ. *Glass Ind.*, **12** [2], 30–35 (1931).—A detailed description of the development, construction, and operation of plate-glass casting tables and their necessary accessories is given. Illustrated. **VI.** *Ibid.*, **12** [3], 52–57 (1931).—Care of a casting table is taken up. In discussing the production of sheets of rolled plate of definite thickness the old and new methods are compared. The various types of rolls that are used in different plants are enumerated and described in some detail, their various advantages and disadvantages being catalogued. The many items which effect or have an influence on the glass thickness, such as expansion of the roll and the casting table, etc., are discussed thoroughly. Rippling or waving of the sheet of glass and methods used to prevent this occurrence are also taken up in detail. Illustrated. For Part IV see *Ceram. Abs.*, **10** [4], 260 (1931). E.J.V.

Fundamental principles of machines for working drawn glass and general rules for plants using automatic methods. F. FRANCESCHINI. *Ind. Silicati*, **8** [12], 7–10 (1930).—Methods of manufacturing glass according to Lubbers, and the principles of the machines of Danner, Fourcault, and Colburn are described. In order to insure normal production in plants with continuous automatic operation, the following points should be observed: (1) regulating production and type of product either by quantity or quality of the ware according to the needs of the market, (2) specialization in production, and (3) production in accordance with periods of maximum and minimum consumption. A certain quantity of ware should be kept on hand. Work should be carried on with maximum regularity and with minimum personnel. M.V.K.

Doghouses. SILBERT GUSS. *Sprechsaal*, **64** [6], 110–14 (1931).—G. discusses the use of doghouses in the German glass industry treating (1) construction, which depends on the kind of furnace used, material to be fused, and the operation of the furnace, (2) requirements of doghouses, and (3) their advantages and disadvantages. M.V.K.

Glass-lined tanks. ANON. *Chem. News*, **142** [3690], 10–11 (1931).—Glass-lined steel vessels, used in the manufacture and transportation of edibles and other susceptible products, are discussed. G.R.S.

Suspended arches in glass furnaces. W. MULLENSIEFEN. *Glastech. Ber.*, **8** [3], 129–38 (1930); *Diamant*, **52** [2], 24 (1930).—The three leading suspended arch systems are the "Vervoort" of the Vervoort-Wanderrost A.-G., the "WIO" of the Westdeutscher Industrie-Ofenbaugesellschaft, Scheidhauer & Giessing, and the "Bigelow" of the Stettiner Chamotte-Werke vorm. Didier. The effect of the construction of the heat transfer in the furnace is discussed in some detail. Some of the installations of these systems are listed with considerable construction data. Illustrated. E.J.V.

Glass laboratory ware. ANON. *Ceram. Ind.*, **16** [3], 246–47 (1931).—Operations in the production of laboratory glassware at the plant of the Kimble Glass Co. are described. Specially developed machines are employed. W.W.M.

Glass tube in new use. ANON. *Nat. Glass Budget*, **46** [45], 25 (1931); *Amer. Glass Rev.*, **50** [22], 32 (1931).—A fragile tube of glass, gas, and metal, capable of hurling the equivalent of a thunderbolt across vast distances, is science's newest contribution to the problem of making electric power as available as water and as cheap. C. W. Stone, consulting engineer of the General Electric laboratories, stated recently that the new

tube, known as the Thyratron tube, had been shown to have almost unlimited uses in power transmission. E.P.R.

Glass and glassmaking. G. McOnie. *Pottery Gaz.*, **56** [644], 274 (1931); *Nat. Glass Budget*, **46** [44], 26 (1931).—In a lecture before the Nottingham and Derby Architectural Society McO. described the processes for making various types of glass, *i.e.*, sheet, polished plate, rough cast, colored, safety glass, health glass, etc., and pointed out that glass is unique because there is no substitute for it. E.J.V.

Action of animal glue and other adhesive substances on glass. Gustav Grünther. *Chem.-Ztg.*, **55** [4], 37–38 (1931).—Test showed that different glues and other adhesive substances injure window glasses. The glasses were opaque and corroded where the glue adhered. The use of starch or vegetable glues is recommended for pasting papers on glass. M.V.K.

Structural glass. Anon. *Literary Digest; Nat. Glass Budget*, **46** [44], 21 (1931).—Structural glass is now available in standard structural shapes, *e.g.*, brick, hollow tile, flat tile, etc. In these forms, glass is being considered for use in the construction of outer and inner walls, partitions, floors, and roof lights in steel and concrete frame buildings. For previous abstracts see *Ceram. Abs.*, **10** [1], 28; [2], 111; [3], 182; [4], 262 (1931). E.P.R.

Use of glass brick. Anon. *Nat. Glass Budget*, **46** [38], 19 (1931).—In Germany they are now blowing glass brick in a variety of colors. E.P.R.

Glass features new building. Anon. *Amer. Glass Rev.*, **50** [23], 27–28 (1931).—In the Starrett-Lehigh Mfg. and Distributing building, covering an entire block in New York, seventeen floors are to be encased in glass. E.P.R.

Church with glass walls. Anon. *Amer. Glass Rev.*, **50** [18], 32 (1931).—A skeleton of reënforced concrete and walls of radiant, translucent colored glass, render unique the Church of Sts. Peter and Nicholas, at Dortmund, Germany. E.P.R.

Luxfer glass prism constructions. Anon. *Arch. Rec.*, **69** [1], 59–62 (1931).—The glass units are pressed glass tile with prismatic, diamond, or modeled surfaces designed to control diffusion and refraction avoiding the usual black appearance of flat glass at night. Description of glass and methods of incorporation in building are given. E.B.H.

Artriplex. Anon. *Nat. Glass Budget*, **46** [39], 14 (1931); *Ceram. Ind.*, **16** [3], 280 (1931).—The first showing to decorators, architects, and home makers of "Artriplex," a new glass, was made January 19, at the Art Center, New York. See also *Ceram. Abs.*, **9** [11], 930 (1930). E.P.R.

New use for glass. Anon. *Nat. Glass Budget*, **46** [44], 17 (1931).—Illuminated glass arrows are being installed above traffic lights on one-way street intersections in Pittsburgh. E.P.R.

Glass window muffler reduces noise and eliminates drafts. C. W. Geiger. *Glass Ind.*, **12** [3], 65–66 (1931).—Glass window mufflers which reduce by 50 to 75% the noise entering open windows facing a busy street, and also eliminate drafts while permitting free passage of air, are being used successfully in San Francisco. The window muffler consists of a combination of inside and outside glass reflectors placed at the bottom of the window, the height of reflectors being about twice the amount of the opening. Illustrated. E.J.V.

Elimination of glass milk bottles in New Jersey. Anon. *Ceram. Ind.*, **16** [2], 197 (1931).—The N. J. State Dept. of Weights and Measures favored the elimination of glass milk bottles and the adoption of paraffined paper containers, but the Bureau of Agricultural Economics of the Department of Agriculture says that the paper receptacles would be more costly. W.W.M.

Production of incandescent lamp bulbs in 1930. A. H. Stricker. *Glass Ind.*,

12 [2], 40 (1931).—Figures for 1930 show that the number of glass bulbs for incandescent lamps of 631,000,000 was 17% in excess of that for 1929. E.J.V.

New window glass plant. ANON. *Ceram. Ind.*, **16** [2], 114–21 (1931).—A detailed, illustrated description is given of the new window glass plant and processes used of the Pittsburgh Plate Glass Co., at Henryetta, Oklahoma. W.W.M.

Pittsburgh Plate Glass Co. sole owner of Duplate Corporation. ANON. *Amer. Glass Rev.*, **50** [19], 25 (1931).—Complete control of the Duplate Corp., manufacturers of safety glass at Creighton, Pa., was acquired by the Pittsburgh Plate Glass Co. on Feb. 3, when the DuPont Viscoloid Co. withdrew from joint ownership in the corporation. E.P.R.

Vineland Flint Glass Co. merged into Kimble Glass Co. ANON. *Nat. Glass Budget*, **46** [39], 3 (1931).—The new company will be known as the Kimble Glass Co. E.P.R.

Glassmaking in Belgium. ANON. *Nat. Glass Budget*, **46** [39], 13 (1931).—Louis Guichardin, writing in 1566, referred to glasses made near Hainaut. These were probably window glasses. The first privileges accorded to families of glassmakers dated from 1467. In 1592 the glassworks of Hamendes was already old. In 1669, Jean de Conde, a Lorraine glassmaker built a glassworks near Charleroi. With the advent of Austrian domination, many glassworks sprang up in the neighborhood of Charleroi from 1727 to 1759. In 1764 there were 20 glass factories in the Austrian Netherlands. E.P.R.

Glass and glassware in Cuba. WILLIAM B. MURRAY. *Commerce Repts.*, **8**, 512 (1931).—The market for glass and glassware in Cuba showed a heavy falling off in 1930. Cuba is producing locally the greater part of her requirements of milk, liquor, and soda-water bottles. Cheap tableware comes principally from Germany and Belgium, but in the first part of 1930 the U. S. led in furnishing finished glass tableware. E.J.V.

New Czechoslovakian glassware. ANON. *Christian Sci. Mon.*, **23** [46], 8; [67], 6 (1931).—Goblets, nappies, stemware of countless shapes and sizes, bowls covered and uncovered, shaped and engraved by hand, present a delicate blending of colors, such as pale green and yellow, amber and red, and green and blue. This modern glass also possesses the advantage of a moderate price. Illustrated. E.J.V.

Spanish glass industry. ANON. *Nat. Glass Budget*, **46** [43], 10 (1931).—It is reported that white glass, etc., works are well occupied, without exception; Ruppert factory has started a second furnace, a new bottle and general factory is under construction at Malaga, black glass bottle factories are working full time, and the window glass factories of Bilbao, Granja, and San Adrian (Libbey-Owens) are busy. E.P.R.

Rare specimens of glass. ANON. *Nat. Glass Budget*, **46** [40], 3 (1931); *Amer. Glass Rev.*, **50** [21], 15–16 (1931).—Alexander Silverman, University of Pittsburgh, possesses a collection of rare and valuable glass which equals if not surpasses any other similar possession in the U.S. or abroad. Many outstanding specimens are described. E.P.R.

Plate glass manufacture in America. ANON. *Nat. Glass Budget*, **46** [44], 23 (1931).—Although over 150,000,000 sq. ft. of plate glass have been manufactured in the U.S. in one year, it was started only half a century ago and then for several years was not a commercial success. E.P.R.

History of glassmaking in New York state. ANON. *Nat. Glass Budget*, **46** [40], 23 (1931). E.P.R.

Early history of English drinking glasses. ANON. *Nat. Glass Budget*, **46** [39], 19 (1931); see *Ceram. Abs.*, **9** [11], 907 (1930). E.P.R.

History of glassmaking. LEONORA R. BAXTER. *Golden Book*, **12** [72], 96–106 (1930); *Amer. Glass Rev.*, **50** [17], 15 (1931).—Glassmaking dates from the 1st Century

B.C. with the blowpipe. Egyptians were early glassmakers of skill and the Romans copied their product. The Romans used glass for more domestic purposes than we do today. The famous Portland vase proves the durability of their material. This vase was supposedly made in the time of Antonius, 138 to 161 A.D. In the 5th Century B.C. Venice took the lead in glass manufacture, monopolizing the industry. Venice removed her glassworkers to the guarded island of Murano, where imprisoned artists brought their art to its supreme height. In the 17th Century Murano degenerated and some artists escaped to Northern Europe where they established glass factories. In the 14th and 15th Centuries the Saracens made glass of great beauty and about this time the Germans began to manufacture coarse heavy glass. India, Persia, Spain, Assyria, and Greece all made glass of distinction at varying periods, but in the long run France, England, Italy, Germany, and the Low Countries achieved and have held the leadership, although America is gaining ground. The glass industry was introduced in Bohemia in the 13th Century. Glass cutting was derived from rock-crystal cutting in 1453. During the first half of the 18th Centu_y "kalligraphen ornamente" became the fad all over Europe. It was a light all-over scroll work covering the entire object in an airy effect. Glass in England began in 657 A.D. but not until 1350 could a glassmaker supply enough flat colorless glass for the windows of St. George's Chapel, Windsor, and the chapel of St. Stephen, Westminster. By 1696 there were eighty-eight factories in England. In Ireland, flint glass produced at Cork and Waterford was the best in the country. In the 6th Century the French were notable glassworkers, improving the process. René Lalique has done the most to rejuvenate the art spirit of his country. Eminent as an architect, maker of jewelry, and worker of iron, he has chosen glass as his medium of artistic interpretation. Kosta, the oldest existing factory in Sweden, founded in 1741, produced a long line of skilled workmen, but until ten years ago, few artists with creative ideas. The necessary combination of technique, capital, and talent was supplied when Johan Ekman of Gottenburg bought the tiny glassworks of Orrefors, and employed Simon Gate and Edward Hald, the former being an impressionistic painter. Glassmaking was America's first industry in 1607. A small bottle factory was started about a mile from Jamestown. Baron William Henry Stiegel brought skilled workmen from Europe to Manheim, Pa., and made richly colored glass. He made clear glass and his colors ranged through green, amber, amethyst, and blue. He also produced painted and enameled glass. Production of glass at Sandwich, Mass., was in 1825 to 1888. The first maker of flint glass in America was Casper Wistar in Salem County, New Jersey, in 1717. Illustrated.

E.J.V.

Glassmaking in ancient times. P. MARTELL. *Ind. Silicati*, **8** [12], 11–12 (1930).—Homer makes no mention of glass and not until 455 to 387 B.C. was the word glass introduced. The art of enameling preceded glassmaking and the latter was problably derived from the former. Glass was first used to coat clay or metal objects or in the manufacture of solid objects. Glassblowing was known in Egypt as early as 2450 to 1800 B.C. Not until the discovery of fine white sand at the mouth of the Volturno did glassworks appear near Cuma and Salermo toward the end of the Roman republic. The Roman art of glassmaking reached its height about 235 to 222 B.C. Glass objects found in excavations at Pompei and other old Roman towns throughout Europe are described. Panes of window glass were found at Pompei. M.V.K.

New glass ingredients and glass technique. W. O. *Diamant*, **51** [35], 684–85 (1929).—A review of some of the patents involving the use of new glass ingredients and new techniques in production is presented. E.J.V.

BOOK AND CATALOGUE

Glass, Its Preparation and Use. F. H. ZSCHACKE. *Z. angew. Chem.*, **43** [52], 1150 (1930); see also *Ceram. Abs.*, **10** [3], 182 (1931). L.T.B.

New Owens-Illinois catalogue shows scope of container industry. ANON. *Amer. Glass Rev.*, **50** [17], 14 (1931).—The catalogue is an encyclopedia and text book. E.P.R.

Good practice specifications for building construction. ANON. *Nat. Glass Budget*, **46** [39], 5 (1931).—This 100-page booklet has been issued by the Construction Industries Division of the Better Business Bureau of St. Louis and refers to glass and glazing, showing how every item is covered in this specification treatise. E.P.R.

PATENTS

Feeding molten glass. KARL E. PEILER. U. S. 1,791,634, Feb. 10, 1931. (1) Apparatus for circulating molten glass, comprising an impeller, means for oscillating the impeller in one horizontal direction, means for oscillating the impeller in a horizontal direction that is transverse to the first-named direction, and means for varying the length of travel of the impeller in one path of oscillatory movement. (2) The method of treating molten glass which comprises supplying glass from a melting tank to a container connected thereto to provide a pool of glass separate from the glass in the tank, and from the surface of which charges of glass are removed in a gathering zone, and circulating the glass in the container in an orbital polygonal path in a substantially horizontal plane and confined to the container, to removed chilled glass from the gathering zone. *Ibid.*, 1,791,635. (1) The combination with a container for molten glass, from which glass may be withdrawn adjacent to one end of the container, of an implement dipping continuously in the glass, and means for oscillating the implement transversely of the container, in a path located adjacent to the end and extending directly across the point of withdrawal of glass, the means comprising a support for the implement that is mounted for sliding movement in a path disposed transversely of the container. (2) The improvement in the glassworking art, which comprises mixing the surface glass of a confined supply body of molten glass by moving an implement back and forth in the glass and maintaining the implement temporarily stationary at the end of a stroke thereof, and periodically withdrawing mold charges of glass from the surface of the supply body in the path of movement of the implement in timed relation to the strokes of the implement.

Apparatus for feeding molten glass. KARL E. PEILER. U. S. 1,791,636, Feb. 10, 1931. In combination with a glass container, a cover for the container, a stirring implement extending through the cover, means for swinging the implement to impart a greater amplitude of movement to the glass contacting portion thereof than to its upper portion, to circulate the glass in the container, the structure of the cover surrounding the implement providing an opening having a slightly greater area at its lower end than at its upper end, to restrict the loss of heat through the cover where the implement passes through it.

Glass machine. CHARLES BADGER. U. S. 1,792,267, Feb. 10, 1931. (1) In a glass bottle-forming machine a mold table, parison-forming molds on the table, automatically-operable means for moving the table to bring the molds successively to a plurality of operating stations including a parison-forming station and a transfer station, means for partially elevating the glass parisons in the parison mold while maintaining the major portion thereof within and centered by the mold, and pneumatically-operated means operable when the mold has reached the transfer station and operating as a result of the operation of the first-named means, and in predetermined timed relation therewith for continuing the elevation of the article to remove it entirely from the mold. (2) In a glass machine, sectional molds adapted to form hollow-glass articles, means for opening the molds, steadying means, and article-gripping means, means for simultaneously actuating the steadying and gripping means to cause the steadying means to engage the mouth end of the article before the molds are opened and to position the grip-

ping means ready to grip the articles, and means operable after the molds are opened to cause the gripping means to grip the article and remove it from the mold.

Paddle mechanism for circulating molten glass. ALEXANDER FRANCIS MCNISH. U. S. 1,792,386, Feb. 10, 1931. The combination with a molten glass circulating trough of a cover for the trough, the cover having an aperture therein, a paddle having a shank extending through the aperture, a holder attached to the shank of the paddle, a horizontal fulcrum for the holder, means for rocking the holder about its fulcrum and means for vertically reciprocating the fulcrum, the fulcrum being situated close to the level of the aperture so as to permit of the provision of only a small clearance between the aperture and the paddle shank.

Apparatus for manipulating plate glass, etc. PAUL DRYON. U. S. 1,792,576, Feb. 17, 1931.

Apparatus for making plate glass. JOHN H. FOX AND WILLIAM OWEN. U. S. 1,792,636, Feb. 17, 1931.

Apparatus for cracking-off and handling sheet glass. CLAUD MOXLEY. U. S. 1,792,653, Feb. 17, 1931.

Method of and means for feeding glass. ALBERT R. BETHEL. U. S. 1,792,727, Feb. 17, 1931.

Glass-feeding apparatus. JOHN F. RULE. U. S. 1,792,932, Feb. 17, 1931.

Apparatus for forming hollow glassware. AUGUST KADOW. U. S. 1,792,988, Feb. 17, 1931.

Apparatus for annealing glass. HAROLD A. WADMAN. U. S. 1,793,199, Feb. 17, 1931.

Draw table and drive therefor. JOHN L. DRAKE AND EDWIN A. ROSIN. U. S. 1,793,783, Feb. 24, 1931.

Sheet-glass drawing apparatus. JOHN L. DRAKE. U. S. 1,793,784, Feb. 24, 1931.

Method of and apparatus for treating glass articles. JAMES BAILEY. U. S. 1,793,893, Feb. 24, 1931.

Glass paving. PIERRE NOËL. U. S. 1,795,229, March 3, 1931. A glass paving block having a substantially circular end surface, the block having a groove formed upon its periphery, the groove including a plurality of plane vertical facets, for the purposes and substantially as described.

Glass sheet drawing apparatus. PAUL ESCOLE. U. S. 1,795,254, March 3, 1931.

Rolling glass. CHANCE BROS. & CO., LTD., AND A. L. FORSTER. Brit. 339,764, Feb. 4, 1931. The manufacture of glass sheets in which wire is embedded, either wire netting or individual wires being used, is described.

Glass manufacture. F. WOLLNER, R. WOLLNER, AND F. NIKOLAI. Brit. 339,903, Feb. 11, 1931. Glass which is transparent to ultra-violet rays is made by adding reducing agents to the batch in order that any iron compounds present in the materials may be reduced to metallic iron during the melting process. A suitable reducing agent consists of aluminium, silica, manganese, zinc, calcium, carbon, or a carbon compound. Aluminium or silicon are especially suited and they may be added to the batch or to the melt in the form of powder or filings.

Rolling glass. C. LOCREILLE. Brit. 339,910, Feb. 11, 1931. The method of making plate or sheet glass which is decorated on one surface with an impressed pattern is described.

Glass manufacture. S. G. S. DICKER. Brit. 340,076, Feb. 11, 1931. Relates to the method of making glass tubes or rods in which cylindrical blocks of glass are threaded on a mandrel or piled in a tube, the lower end of the mandrel or tube being shaped to support the blocks.

Molding building blocks. J. BRAUN. Brit. 340,078, Feb. 11, 1931. A channeled

block with one closed end is formed by molding the block with holes extending therethrough, then introducing a plunger or plungers to strip material from the walls of the channels and compress it to form a closing wall.

Tempering sheet glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY ET CIREY. Brit. 340,108, Feb. 11, 1931; Fr. 686,890, March 13, 1929. A process for tempering sheet glass consists in heating a sheet, while suspended in a vertical position, to a uniform temperature corresponding to that at which the glass commences to soften, and then subjecting the hot glass to the action of powerful jets of air directed at right angles upon the two faces of the sheet until complete cooling of the glass is effected. See also *Ceram. Abs.*, 9 [12], 1044 (1930).

Glass furnaces. HARTFORD-EMPIRE CO. Brit. 340,110, Feb. 11, 1931. The nose portion of a glassmelting tank is divided into a number of compartments which are maintained under different working conditions to suit the different requirements of a number of gathering devices.

Forming silica-glass articles. QUARTZ ET SILICE. Brit. 340,167, Feb. 11, 1931. A method of molding an article of fused silica consists in attaching a silica blank to a mold with an air-tight joint between them, and producing suction between the mold and one face of the blank while heat is applied to the other face.

Nonsplintering glass. JOHN NEWTON. Fr. 648,085, Feb. 2, 1928; Ger. 505,862, Feb. 1, 1928. One face of each of two glass sheets is coated with a solution of albumin in distilled water and dried. Pyroxylin in ether, alcohol, or amyl acetate is applied and dried, and the coated surfaces are united to a celluloid sheet which has been immersed in a solution of dimethylamine in spirit. The edges of the compound sheet may be sealed by celluloid or collodion solution. (*C.A.*)

Reënforced glass. MARIA SCHMIDT. Fr. 686,271, Dec. 7, 1929. The celluloid and the contacting faces of the sheets of glass are coated with a vegetable or chemical resin and the whole is plunged into a bath composed of C_6H_6 xylene, $CHCl_3$, turpentine, cedar oil, and other oils. (*C.A.*)

Sand, clay, etc., used for glassmaking. CHANCE BROS. & CO., LTD. Fr. 686,426, Dec. 11, 1929. Fe is eliminated from sand or other material used for glassmaking by heating the sand and treating it with a reducing gas such as H, CO, or SO_2, and simultaneously or subsequently with Cl. (*C.A.*)

Reënforced glass. HUMPHREY D. MURRAY AND DOUGLAS A. SPENCER. Fr. 686,961, Dec. 19, 1929. The intermediate flexible layer in reënforced glass is made of regenerated cellulose or viscose impregnated with gelatin or a gum solution in water, and a polyhydric alcohol such as glycerol or glucose or a mixture thereof. (*C.A.*)

Machines for working molten silica. COMPAGNIE FRANÇAISE POUR L'EXPLOITATION DES PROCÉDÉS THOMSON-HOUSTON. Fr. 686,989, Dec. 20, 1929. (*C.A.*)

Coloring reënforced glass. HUMPHREY D. MURRAY AND DOUGLAS A. SPENCER. Fr. 687,049, Dec. 20, 1929. The intermediate layer of reënforced glass is colored by a diazotype process. (*C.A.*)

Safety glass. JACQUES VANDIER. Fr. 688,543, April 11, 1929. In assembling sheets of glass and celluloid by a viscous substance such as Canada balsam for making safety glass, all possibility of the components sliding with respect to one another is eliminated by solidifying the viscous substance on the periphery of the plates, particularly by allowing the atmosphere to come in contact with the viscous substance to a certain depth. (*C.A.*)

Device for producing tubes or rods from fused quartz. ALLGEMEINE ELEKTRIZITÄTS-GESELLSCHAFT. Ger. 507,839, Jan. 16, 1926. (*C.A.*)

Glass. FRITZ ECKERT. Ger. 508,114, March 5, 1927. Between the clarifying chamber and the place of withdrawal, an additional chamber is arranged in which the

molten glass is subjected to mechanical agitation at a temperature substantially above the working temperature. It is then led away and cooled as rapidly as possible to the working temperature. (*C.A.*)

Structural Clay Products

Behavior of bituminous shale clays during firing. F. KRAZE. *Ber. deut. keram. Ges.*, **11** [9], 475 (1930).—K. tested two different grain sizes of a shale clay with about 5% bituminous substances. The purpose was to find out what conditions had to be used to make good "German Klinker" from such a material. Longer wet soaking will favorably influence the firing behavior of the material. Results on raw material and the same weathered moist for four weeks are given. Addition of barium carbonate aids burning out of the bituminous substances. K. thinks, however, that neither addition of barium carbonate nor the weathering will suffice. The addition of fine grog flour of the same shale clay fired at 950° improved the clay. Manganese oxide is most effective in that it speeds up, by oxidation, the burning out of the bituminous substance. Further tests are under way. I.R.

Clay base for drain tile. RIC-WIL CO. *Brick Clay Rec.*, **78** [2], 73 (1931).—An innovation for vitrified tile conduit is a vitrified tile drain as a foundation under the conduit made with the Loc-liP joint. E.J.V.

Pressing plastic clays. W. NEIMAN. *Tonind.-Ztg.*, **55** [11], 161–62 (1931).—N. describes the preparation of plastic clays for the dry-press process. The raw clay is dried and sent into different pulverizing machines after which the material is molded in hydraulic presses with unilateral or bilateral pressure. The unilateral pressure attains about 500 kg./sq. cm. and the bilateral 300 kg./sq. cm. M.V.K.

Use of barium to prevent efflorescence. ANON. *Corriere ceram.*, **11** [12], 501–503 (1930).—Barium carbonate for preventing efflorescences in brick is added by either the wet or the dry process, depending on local conditions. Most plants use the wet method with satisfactory results. In both cases it is important that the clay and barium carbonate be thoroughly mixed and that both constituents be fed uniformly and simultaneously, preferably by mechanical distributors. M.V.K.

Tentative methods of testing brick (compression, flexure, and absorption). A.S.T.M. C67-30T. *Proc. A.S.T.M.*, **30** [I], 1033–36 (1930).—Apparatus for making the compression and flexure tests of brick, preparation of test specimens, number of specimens, and procedures involved are described. Details are also given of number of specimens and procedure involved in making absorption tests. R.A.H.

Resistance to pressure of hollow and whole brick. ANON. *Tonind.-Ztg.*, **55**, [7], 102–103 (1931).—Tests on the resistance to pressure of hollow and whole brick showed that the resistance to pressure of hollow brick exceeded that of whole brick on an average of 21%. M.V.K.

Results of freezing and thawing tests made with clay face brick. L. A. PALMER AND J. V. HALL. *Proc. A.S.T.M.*, **30** [II], 767–82 (1930).—Four types of face brick were studied for relationship between resistance to freezing and thawing of saturated brick and their percentages of absorption. The data do not present evidence in conflict with the general belief that there is no definite relationship between the absorption and the weather resistance of clay brick when various types of products are considered. See also *Ceram. Abs.*, **9** [12], 1045 (1930). R.A.H.

Frost action on drain tile. DALTON G. MILLER. *Brick Clay Rec.*, **78** [3], 134–35 (1931).—The frost-resisting quality of clay tile is largely dependent on the quality and handling previous to and during firing. Tile must be well fired to resist freezing. High-quality clay tile were not affected by exposures that caused considerable loss in tile of

poorer quality. Tests were made on tile from 26 plants in Minnesota and Iowa, both by the absorption and freezing and thawing methods. Illustrated. E.J.V.

Projects at Roseville experimental clay products plant. J. O. EVERHART. O. S. U., *Eng. Expt. Sta. News*, **2** [9], 7 (1931).—The following projects are being studied: (1) Lawrence County clays, (2) dry-press refractories, (3) dry-press paving brick, (4) power consumption in clay plant operation, (5) industrial test work, and (6) use of fuels in brick kilns.

Stiff-mud die troubles. ELLIS LOVEJOY AND H. B. HENDERSON. *Clay-Worker*, **95** [2], 125–27 (1931); see also *Ceram. Abs.*, **9** [12], 1045 (1930). E.J.V.

Brick drying. W. GIECHE. *Tonind.-Ztg.*, **55** [9], 155 (1931).—G. discusses brick drying and demonstrates the excessive loss of heat in annular kilns. M.V.K.

Brickwork and its construction. WALTER R. JAGGARD. *Jour. West. Soc. Eng.*, **36** [1], 65 (1931); see also *Ceram. Abs.*, **9** [12], 1050 (1931). W.W.M.

One hundred and five holes reduce weight of brick. KURT SCHULTHEISS. *Brick Clay Rec.*, **78** [4], 210–12 (1931).—A cellular brick produced in Europe is 9.84 x 4.72 x 2.56 in. in common form or 9.84 x 4.72 x 4.1 in. in the larger size, contains 105 holes, and is manufactured by extrusion. This saves about 35 or 40% in weight. Heat insulating and sound insulation values are good. It is easily broken into odd shapes and has a cross-section compressive strength of 4495 lb./sq. in. Illustrated. E.J.V.

Light-weight brick experiment proves successful. KNOX HARDING. *Clay-Worker*, **95** [2], 129 (1931); for abstract see *Ceram. Abs.*, **10** [3], 189 (1931). E.J.V.

Light-weight brick. G. LAGOUNOFF. *Bldg. Materials*, No. 9–10, 7 pp. (1930).—L. discusses the properties of different kinds of light-weight brick manufactured in U.S.S.R. from diatomaceous earth, pumice stone, tufa, and other materials. Data on their properties and qualities are given. M.V.K.

Production of brick with glazed surfaces. HANS HIRSCH AND BRUNO SPITTA. *Tonind.-Ztg.*, **55** [10], 142–43 (1931).—Three ways of obtaining brick with glazed surfaces are discussed: (1) salt method, (2) method of coating with engobe, and (3) admixtures to the clay or paste. M.V.K.

New structural clay tile design. H. D. FOSTER. O. S. U., *Eng. Expt. Sta. News*, **2** [9], 4 (1931).—A new design by F. embodies certain of the old and desirable features together with new features resulting from much research on clay tile.

Sand-lime brick. I. F. PONOMAREV. *Bldg. Materials*, No. 9–10, 7 pp. (1930).—P. describes the manufacture of sand-lime brick including (1) influence of the composition of silica brick on their stability, *i.e.*, the proportion between lime and sand; (2) microstructure of the grain of silica brick; (3) influence of the quantity of water used for mixing lime and sand on the stability of brick; (4) influence of the size of grain on the stability; and (5) influence of the pressure during pressing of the brick. M.V.K.

Design of brick and tile walls. J. R. SHANK AND H. D. FOSTER. O. S. U., *Eng. Expt. Sta. News*, **2** [9], 7 (1931).

Hand brickmaking and dry-brick presses. FRIEDRICH LIPINSKI. *Tonind.-Ztg.*, **55** [11], 156–58 (1931). M.V.K.

Automatic brick cutters. J. G. SEANOR. *Brick Clay Rec.*, **78** [2], 91–94 (1931).—Cutting brick and automatic brick cutters are discussed. Illustrated. E.J.V.

Merits of Brictile. E. F. ZERGA. *Brick Clay Rec.*, **78** [2], 72 (1931).—Brictile, a lower Kittanning fireclay stiff-mud product will withstand heat in a conflagration. Its size makes possible one unit for stretcher, header, and corner block. The vertical holes anchor mortar and make a perfect bond. All exposed surfaces of Brictile are glazed. E.J.V.

Large units in a commercial job. ANON. *Brick Clay Rec.*, **78** [4], 220 (1931).—The Kittanning Brick Co. made a special unit 5 x 8 x 8 in. and 5 x 8 x 12 in. with

a speckled glazed face and weighing from 15 to 16 lb. for use in the Carew Towers in Cincinnati. E.J.V.

Reënforced brickwork; its performances and opportunities. HUGO FILIPPI. *Clay-Worker*, **95** [2], 112–13 (1931); *Brick Clay Rec.*, **78** [3], 156 (1931).—The active development of reënforced brickwork must take form in the following three phases: (1) as a scientific research problem, (2) its practical application to buildings and other types of structures, and (3) as a definite agency for increasing the sale of brick. Some of the tests which have already been made on reënforced brickwork are discussed. See also *Ceram. Abs.*, **10** [4], 269 (1931). E.J.V.

New colors and textures. FRANK C. MAHONEY. *Brick Clay Rec.*, **78** [3], 166 (1931).—Brick that look like lustrous gold from one angle and a warm red from the other and brick that resemble the ruggedness of natural stone open possibilities for the clay products industry. Illustrated. E.J.V.

New clay product. M. McC. EVERHARD. *Brick Clay Rec.*, **78** [3], 168 (1931).—Volkanick Lavah is a shale product resembling crumbling lava, and is being used for rock gardens and artistic or ornamental work. There is a good range of colors from dark browns and blacks of shale to the lighter tones of fire clay, as well as color schemes secured by use of chemicals. Illustrated. E.J.V.

Winter labor in brickworks. HANS KREMSKI. *Tonind.-Ztg.*, **55** [6], 80–81 (1930).—K. discusses the working conditions in brick plants in winter. M.V.K.

Meeting of brickmakers. ANON. *Tonind.-Ztg.*, **55** [8], 109–11 (1931).—Among the subjects discussed at the meeting of brickmakers in Berlin from February 5 to 7, the following may be of interest: (1) "Outline of geology for brickmakers," by Pulfrich; (2) "Clay mining of today," by Schwamberger; (3) "Valuation of power machines and installations with regard to heat management of today," by Laaser; (4) "Clinker and ceramic plates, their preparation and use," by Mauss; (5) "New preparing and molding machines, and transport installations," by Voland; (6) "Brick drying with special regard to increase in output of plants," by Thor; (7) "Operation and management of brick and clinker kilns, working periodically and continually," by Heuer; (8) "Technical operation control," by Thomas; and (9) "Manufacture of hollow and porous light brick," by Hielscher. M.V.K.

Brick wall duplicates coursed ashlar. ANON. *Bldg. Econ.*, **7** [1], 4–5 (1931).—Recently skintled brickwork has received rapid recognition because of its radical departures from conventional types. Colored brick in new sizes ranging as large as 9 x 12 in. are manufactured by the Bolder Brick & Tile Co., Colo., and by E. T. Mankin, Va. E.P.R.

Unusual brick uses. ANON. *Bldg. Econ.*, **7** [1], 13 (1931).—A few examples of unusual uses for brick are given and a plea is made for an increase in such constructions. E.P.R.

Hidden strength of ordinary brick walls. ANON. *Bldg. Econ.*, **7** [1], 11 (1931).—The article discusses the value, economy, and strength of the use of brick in construction, and points out that brick withstands the ravages of both fire and time. E.P.R.

History of reënforced brickwork. JUDSON VOGDES. *Clay-Worker*, **95** [2], 110–12 (1931); *Brick Clay Rec.*, **78** [3], 156 (1931).—A brief summary of the history and development of reënforced brick masonry is presented. See also *Ceram. Abs.*, **10** [2], 117 (1931). E.J.V.

Romance of brick. LOUIS J. CARROLL. *Clay-Worker*, **95** [2], 113–14 (1931).—This is the text of a brief nontechnical radio talk on the growth of the use of brick in building in America. E.J.V.

Hudson River brick industry convalescing. ANON. *Brick Clay Rec.*, **78** [4], 207–208 (1931). E.J.V.

Sand-lime brick industry in Europe. E. L. HARRIS, A. W. DONEGAN, L. J. KEENA, AND C. W. CANNON. *Commerce Repts.*, No. 5, pp. 292–94 (1931).—Sand-lime brick can be manufactured wherever crushed stone and lime or siliceous sand can be brought together economically. Its manufacture in Switzerland has reached a high technical development so that it is rapidly displacing clay brick. In Germany sand-lime brick have been manufactured steadily for more than 30 years, and especially in the postwar period. The economic success of the industry in France and Austria was apparently temporary. There is a variation in the characteristics of sand-lime brick according to the raw materials available. Special uses in Switzerland, the organization of Swiss manufacture and trade, and present trends and market outlook are discussed. The German demand for sand-lime brick and their comparison with clay brick are taken up. Raw materials regularly demanded by German factories, French requirements for sand-lime brick, and the status of the industry in other European countries are enumerated. Illustrated. E.J.V.

Dutch brick plant. ANON. *Klei*, **22** [22], 262–64 (1930); *Tonind.-Ztg.*, **55** [10], 154 (1931).—The Beret & Co. brick plant in Dubbeldam, Holland, with a production of about 9.5 million brick per year is described. The clay is soaked and weathered for several months. M.V.K.

Modern Swedish brick plant. ANON. *Tegel*, **20** [10], 76–80 (1930); *Tonind.-Ztg.*, **55** [11], 168 (1931).—A description of the Kungshatts brick plant near Stockholm is given. Porous brick are made from a fat, hard clay and are fired in an annular kiln having 24 chambers and a firing channel 102 m. long. M.V.K.

Better brick and brickwork in Japan. ANON. *Bldg. Econ.*, **7** [1], 15 (1931).—The earthquake in 1923 in Japan has speeded up Japanese acceptance of brick as a first-quality building material. Today the majority of factories and large constructions are built of brick. E.P.R.

Manufacture of clay roofing tile in France, Belgium, and Holland. W. A. MCINTYRE AND A. ZAIMAN. Dept. Sci. Ind. Research, Bldg. Research, *Bull.*, No. 4 (1928); for abstract see *Ceram. Abs.*, **8** [2], 128 (1929). W.L.

Rebuilding colonial America with brick. ANON. *Brick Clay Rec.*, **78** [3], 162–64 (1931).—Both at Wakefield and Williamsburg, Va., in the work of restoration of colonial America, hand methods and open-air drying together with wood-firing are being used in producing the uneven colored brick that must have been a feature of the original structures which are being restored now. Illustrated. E.J.V.

Ceramic industry in Australia. C. CALLISTER. *Refrac. Jour.*, **6** [64], 131 (1931); for abstract see *Ceram. Abs.*, **10** [1], 80 (1931). E.P.R.

BULLETIN

Brick roads and jobs. ANON. Nat. Paving Brick Mfrs. Assn., *Statistical Bull.*, **11** [3], 3 pp. (1931).—Under the above caption, the Johnstown, Pa., *Democrat* published three editorials, January 3, 5, and 6, 1931. Prejudice against brick roads has grown to alarming extremes. Obviously, the Cement Association has powerful influence with the Pennsylvania State Highway department. Of $84,000,000 out of current revenues for new highways in 1929 and 1930 only a few dollars were used to buy brick. Yet brick manufacturing is a Pennsylvania industry. Thousands of unemployed in the state could be put to work making brick if the highway department would build some brick roads.

PATENTS

Brick machine. HUMBERT M. FENATI. U. S. 1,793,216, Feb. 17, 1931. In a brick machine having an extruding die and a surrounding casing in advance thereof a reciprocable pusher within the casing and below the path of an extruded product.

Brick mold. J. ADDISON CROWELL. U. S. 1,793,306, Feb. 17, 1931. In a multi-brick mold, a wooden bottom panel completely covers the bottom of each individual mold.

Brick-lifting and transferring mechanism. IRVEN H. WILSEY. U. S. 1,793,576, Feb. 24, 1931.

Composite brick. EDWIN M. WYATT. U. S. 1,794,572, March 3, 1931. A composite building unit comprising a fired brick facing section of argillaceous material and a concrete backing section consisting of an aggregate of prepared fired argillaceous particles and a cementitious binder, the binder in the backing serving also to unite the two sections.

Brick setter. GRAFTON E. LUCE AND FRANK G. SENTER. U. S. 1,794,698, March 3, 1931.

Furnace arch. INGEMON MOE AND CHARLES A. SMITH. U. S. 1,794,705, March 3, 1931.

Water-cooled furnace arch. INGEMON MOE AND CHARLES A. SMITH. U. S. 1,794,706, March 3, 1931.

Hollow brick or wall construction. WILLIAM J. WILKINS. U. S. 1,795,001, March 3, 1931.

Refractories

Proportioning refractory materials. I. Grog refractories. SEIJI KONDO. *Jour. Jap. Ceram. Assn.*, **37** [442], 411–23 (1929).—Experiments have been made on the effect of the ratio of grog to clay, fineness of grog and clay, and the method of molding upon the softening behavior under a load of 2 kg./sq. cm., compressive strength, P.C.E., resistance to spalling, and other physical properties of grog refractory made of a hard clay containing 41.49% Al_2O_3 and a common clay containing 37.82% Al_2O_3, both produced in Fukushu, Manchuria. Results: (1) If the fineness of the grog remains constant the softening temperature under load rises with the proportion of the raw clay up to a certain limit, and if the same clay is used for grog and bond, the yielding curves are almost parallel to one another. (2) When the proportion is constant, bodies containing grains of varying size or those made solely of fine powder soften under load at the highest temperatures and yield gradually, though too fine grinding may sometimes be useless. (3) In most cases, the softening temperature under load rises with compressive strength, provided the refractories are made of the same grog and clay. (4) The refractories with low compressive strength are apt to spall. **II. Diaspore refractories and amalgatolite refractories.** *Ibid.*, **37** [442], 423–34 (1929).—Similar experiments have been made of *D* refractories prepared by binding Mitsuishi diaspore grog with Korean kaolin, Sanage Kibushi-clay, or pulverized diaspore, *E* those prepared by binding the diaspore grog and the kaolin grog with the kaolin, and *K* those prepared by binding Mitsuishi amalgatolite, its grog, and the Kibushi-clay grog with the Kibushi-clay. Results: (1) As to the softening behavior of the refractories *D* under load, the Kibushi-clay is a better bond than the kaolin. The softening point is lowered with the increase of the Kibushi-clay. The refractories bonded with pulverized diaspore show high softening point and yield slowly. (2) In the refractories *E*, the softening point and the temperatures causing 0 to 5% yield in height are lowered directly with the increase of the kaolin grog. (3) In refractories *K*, those containing no amalgatolite grog, *e.g.*, 80% raw amalgatolite + 20% Kibushi-clay, show satisfactory results in the load test. A specimen composed of 40% raw amalgatolite, 40% Kibushi-clay grog, and 20% raw Kibushi-clay is the best proportion. (4) The refractories composed of more than 80% of diaspore grog and less than 20% of the kaolin have spalled. (5) The softening behavior of the refractories is con-

nected with their absorption, porosity, and bulk specific gravity while its relation to compressive strength is not distinct. **III. Silica refractories.** *Ibid.*, **37** [443], 476–85 (1929).—Experiments have similarly been made of silica refractories. Two kinds of so-called red-white quartzite whose red portions consist chiefly of an intimate mixture of fine quartz grain and minute hematite, of Tamba, and ordinary quartzites of Ryojun and Taikozan in Manchuria have been used. Results: (1) *Apparent specific gravity.* If firing temperature is not sufficiently high and remains the same, apparent specific gravity is lowered with increase in fineness of quartzite. If the fineness is constant, a maximum is found with a certain amount of lime. If magnesia is used instead of lime, the specific gravity rises with the proportion of magnesia. (2) *Fineness of quartzite.* Its effect upon the softening behavior under load is little. Excellent results have been obtained with the proportions as 20% 3 to 2 mm., 20% 2 to 1 mm., 30 to 20% 1 to 0.5 mm., 30 to 40% 0.5 to 0 mm. grains of Tamba quartzite and 2.0% CaO. (3) *Lime.* The highest softening temperature under load has been shown with 2.0% lime for the Tamba quartzite. Specimens made of 100 parts quartzite and 2.0 parts magnesia have given an excellent result in the load test. (4) *Strength.* The compressive strength varies as fineness of quartzite and amount of bond vary. For the range of from 1.0 to 3.0% of quartzite, the strength increases directly with the amount of lime. Specimens bonded with magnesia are weak. (5) *Spalling.* As to the resistance to spalling, the ordinary quartzites are better than the red-white quartzites. **IV. Semi-silica, silicon carbide, and magnesia refractories.** *Ibid.*, **37** [443], 486–97 (1929).—Semi-silica refractories made of the Tamba quartzite and the Kibushi-clay, with or without addition of the Kibushi grog, silicon carbide refractories with clay bond, and magnesia refractories have similarly been experimented. Results: (1) *Semi-silica refractories.* The refractory with even a small proportion of clay softens at a markedly lower temperature than silica refractory. The refractory poor in clay content yields rapidly. (2) *Silicon carbide refractories.* Silicon carbide refractories with clay bond soften under load, in general, at low temperatures. The softening temperature and the rate of yielding under load undergo intense influence by the fineness of silicon carbide. The softening point under load has attained a maximum at about 30% of clay. The temperature at which specimens made of 80 to 90% silicon carbide with even proportions of 16, 24, 36, and 100 mesh/sq. in. grains, and 20 to 10%, and 10%, respectively of the kaolin or the Kibushi-clay, yield more than 3% in height under a load of 2 kg./sq. cm. is probably higher than 1600 to 1700°C. (3) The softening behavior under load of magnesia refractory is influenced by the fineness of the dead-burned magnesite. The use of caustic magnesia is disadvantageous in this respect. **V. Finely-ground mixtures of clay, amalgatolite, quartz, feldspar, etc.** *Ibid.*, **37** [444], 545–56 (1929).—Results: (1) The temperature at which specimens made of the aluminous Fukushu hard clay and Akazu Kibushi-clay yield 0 to 5% in height under a load of 2 kg./sq. cm. is markedly raised by pulverizing them. Whereas in mixtures of the Mitsuishi diaspore and the Kibushi-clay, or Mitsuishi amalgatolite and the Kibushi-clay the rate of yielding is hastened. (2) Pulverized Korean kaolin yields very gradually. A mixture of 70% kaolin and 30% Karita quartz shows a somewhat higher softening point and yields quickly. An addition of Karita feldspar up to 30 to 70 parts of the kaolin raises the 0 to 2% yielding temperatures a a little and lowers the 4 to 5% yielding temperatures slightly. The relations between the softening temperature, the rate of yielding, compressive strength, porosity, specific gravity, P.C.E., etc., are discussed as in the preceding reports. S.K.

Firing shrinkage of several clays. JOFU YAMAGUCHI. *Jour. Jap. Ceram. Assn.*, **37** [435], 92–95 (1929).—This report deals with the results obtained from a study of firing shrinkage of typical Japanese and Chinese fire clays. Test pieces prepared of semi-wet powder have been fired to 800 to 1580°C in an electric furnace or to cones 10

to 18 in commercial kilns. Results are as follows: (1) Every clay has shrunk most excessively at the interval 1000 to 1100°C. (2) The home clays begin to expand at about 1400° due to transformation of quartz and formation of fine cracks. (3) Among Chinese clays, Fukushu clay shrinks up to 1500° and Hakusan clay does not expand even at 1580°. Their chemical compositions and P.C.E. are shown in Table I.

TABLE I

	Loss on ignition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	P.C.E.
Fukushu clay	13.77	44.04	38.26	2.78	Trace	0.72	34
Hakusan clay	14.56	45.40	38.62	1.01	Trace	0.16	35

Scorification of refractory materials. III. HERMANN SALMANG AND FRIEDRICH SCHICK. *Arch. Eisenhüttenwesen*, No. 2, p. 98 (1928–29). **IV.** *Ibid.*, No. 4, p. 299 (1930–31); *Stahl Eisen*, **50** [52], 1814 (1930).—The action of oxides, binary and ternary silicates, and a series of silicate fusions on refractory materials were studied. The tests were made on grog at 1410° and 1500°, and as grog softens at higher temperatures, sillimanite was used (1580°). Calcium oxide is the strongest base in all fusions; ferrous oxide next, and then manganese oxide. Magnesium oxide is like ferrous oxide in its action. Iron oxide is stable in silicate fusions up to 1580° while manganese oxide disintegrates at 1500°. Alkalis do not appear as strongly basic at high temperatures as at low temperatures. The oxide of potassium reacts weakly. This is surprising since alkalis develop a high heat of formation during the formation of silicates. This is in contrast with alkaline earths which react basically in fusions although they contain a fifth of the heat of formation of alkalis. The solidly combined alkali silicates cannot dissociate in oxides while lime silicates easily dissociate. Since only uncombined oxides, but not salts nor silicates, can react, then only free lime can react. If great quantities of alkalis are added, the part not combined with salts is active. Phosphorous pentoxide behaves similarly. As an acid it stops the action of bases, but if a surplus of this oxide is present it acts strongly at high temperatures. The action increases about 50% by increasing the temperature from 1410° to 1580° and it can be concluded that the dissociation of the fusions also increases in equal proportion. The results of slagging tests show the constitution of slag because they express the composition and dissociation, at the time, through chemical reactivity. The following formulas correspond to the amount of reacting oxides of slags. For the basic slags (composition expressed in per cent by weight), the scorification K in mm. of dissolved crucible material equals: for 1410° $K = 1.25 \cdot \frac{7(CaO) + 7(MgO) + 5(FeO) + 4(MnO)}{(Al_2O_3) + 2(SiO_2) + (Fe_2O_3) + 5(P_2O_5)}$ mm. For 1500° $K = 1.8 \cdot \frac{7(CaO) + 4(MgO) + 4(FeO) + 3(MnO)}{(Al_2O_3) + 2(SiO_2) + 0.5\,(Fe_2O_3) + 2.5\,(P_2O_5) + (TiO_2)}$ mm. **V. Dependence of scorifying of grog blocks on the flux content and porosity.** HERMANN SALMANG AND OTTO HEBESTREIT. *Feuerfest*, **7** [1], 1–8 (1931).—The authors describe their researches on (1) the influence of fluxes in a synthetic ceramic body, (2) influence of fluxes on grog, (3) influence of the porosity, and (4) influence of the structure. The following observations were made: (1) Crucibles containing alumina and silicic acid only in the proportion of $1Al_2O_3$ to $2SiO_2$, and others to which fluxes were added were prepared. They were scorified with slag of ordinary composition. No difference was found between the pure crucibles and those containing fluxes, probably on account of the great porosity of the bodies. (2) Crucibles were made from fired and unfired Zettlitz kaolin. Some crucibles contained 25% oxide fluxes, others 4%. The latter were more affected than the former which had the same stability as the crucibles without admixtures. The

strongest scorification is brought about by TiO_2, Fe_2O_3, and CaO when they are present only in the crucible or only in the slag. Similar kinds of oxides present in slag or body produce slight scorification, as does Na_2O when present in the slag or in the body. (3) Thirty-eight standard blocks were exposed to blast-furnace slag rich in lime and to slag rich in iron. It was found that slagging is not proportional to porosity. The scorification does not depend on the quantity of large pores which was determined by the glycerine absorption of a block at 20°C. The scorification increases with increased porosity only when homogeneous blocks which differ only in porosity are used. (4) The structure of the blocks is of the greatest importance in scorifying. Blocks with occluded pores which are either separated entirely or connected by only narrow channels are strongly affected by viscous lime slag and thinly liquid iron slag. Blocks of uniform composition, equal porosity, and similar structure show the same effect with blast-furnace slag. If the blocks in spite of the uniform composition and equal porosity are differently affected this can be explained by their different structure. For Part II see *Ceram. Abs.*, **9** [2], 110 (1930). M.V.K.

Mechanical dressing of refractory brick. O. BARTSCH. *Glastech. Ber.*, **8** [3], 138–48 (1930); *Diamant*, **52** [1], 3–4 (1930).—Some special machines are described. The types of cutting media used are enumerated. Some of the economic advantages of machining refractories in increasing life, decreasing the construction time, reduction of amount of mortar required, etc., are listed and discussed. Illustrated. E.J.V.

Effect of grain size distribution on the density of refractory materials. K. LITZOW. *Glastech. Ber.*, **8** [3], 149–53 (1930).—Experiments were conducted on the relationship between the packed weight and grain size distribution of grog. A well-defined maximum of the packing weight was determined for two quite different types of grog for approximately the same grain size distribution, consisting of equal portions of three grades: 2 to 5 mm., 0.25 to 2 mm., and 0.0 to 0.25 mm. Further, a close relation was found between the packed weight of various grain-size mixtures and the porosities of the fired bodies produced therefrom. A far-reaching parallel between the packing weight of the grogs and the density of the bodies made with them was obtained. Illustrated. E.J.V.

Report of Committee C8 on Refractories. ANON. *Proc. A.S.T.M.*, **30** [I], 472–77 (1930).—The report states that the committee approved (1) a number of recommendations of the section on temperature involving changes in the standard P.C.E. test, sampling of test materials, and the manner of preparing the test cones to make the test applicable to raw fire clay and silica cements. (2) The recommendations of the section on heat transmission regarding standard nomenclature are the same as those of the National Research Council. The committee now has in progress, with the Bureau of Standards, the preparation of standard samples of chrome, magnesite, and silica materials of the usual commercial grade. Members of this committee are coöperating with the A.S.M.E. special Boiler Furnace Refractories Committee which has had under way for several years a thorough study both in the field and laboratory of the action of coal-ash slags on various fireclay brick. R.A.H.

Manufacture and properties of carbidic and nitridic crucibles. O. MEIER. *Ber. deut. keram. Ges.*, **11** [6], 333 (1930).—M. tried to find a new material suitable for melts at high temperatures of metals as well as all oxides. The carbides tested were Cr_3C_2, MO_2C, W_2C, WC, and SiC. The carbidic crucibles were bonded with glucose. M. gives special data about the manufacture of the crucible, sintering temperature, etc. All of the carbidic crucibles did not stand the influence of pure metals. All of them, however, withstood the melting influence of the so-called oxides. Only copper did not attack. A mixture of chromium tungsten-carbide was also tried but with no better results. Silicon carbide was less resistant against the influence of the oxides. From the nitridic crucibles,

titanium nitride was most favorable. None of the metals attacked this crucible, but all the oxides were harmful. The determination of the reaction between carbides and oxides is given. It has not been possible to develop a crucible material suitable for metals as well as for oxides. Titanium nitride is a new material which is resistant against pure metals as well as such metals containing carbon, and which is superior to the ordinary mixture. I.R.

Refractories in the gas industry. FRANK WEST. *Refrac. Jour.*, **6** [64], 132–36 (1931).—In the gas industry refractories are used not only in the retort house but also by the consumer in the form of apparatus for heating and lighting. In the gasworks the retort settings are built entirely of refractory materials. A brief history of the development of clay retorts is given starting with the use of refractories in ancient days. The progress of refractories in the gas industry is discussed at some length and reference is made to the importance of standardization. E.P.R.

Properties of fire clays. R. A. HEINDL AND W. L. PENDERGAST. *Refrac. Jour.*, **6** [64], 148 (1931); for abstract see *Ceram. Abs.*, **9** [11], 939 (1930). E.P.R.

Penetrability of silica blocks, mortar joints, and brickwork by gas. ANON. *Tonind.-Ztg.*, **54** [1], 17 (1930); for abstract see *Ceram. Abs.*, **9** [5], 356 (1930). M.V.K.

Study of the necessary grain size composition of the grog in order to develop a maximum dense grog brick. R. RIEKE AND J. GIETH. *Ber. deut. keram. Ges.*, **11** [7], 394 (1930).—It was attempted to develop a certain composition of different grain sizes which were of maximum density. The space between the grains and the degree of filling for different grain sizes were determined. Grog mixtures of well-known grain composition were tested for their drying strength. Eight of the most favorable grain mixtures were mixed with Zettlitz kaolin sufficient to fill the spaces between the grains. I.R.

Scientific thermal principles of industrial furnaces. G. ZOTOS. *Rev. Métal.*, **27** [7], 352–61 (1930); *Metal Prog.*, **18** [6], 168 (1930).—It is claimed that elevation of temperatures is not feasible with actual furnaces because refractory materials cannot resist flame temperatures that are too high. E.P.R.

Gas permeability of refractory materials at high temperatures. H. IMMKE AND W. MIEHR. *Sprechsaal*, **64** [5], 85–87; [6], 107–109 (1931).—Tests made to determine the gas permeability of refractory materials at high temperatures are described. The results are tabulated and show that gas permeability (1) is directly proportional to pressure, and (2) depends on the temperature, being lower at higher temperatures. Two methods are described, one used for materials difficultly permeable. It is shown how the results of tests with air can be used for other gases. M.V.K.

Diminishing breaking of fire brick. ANON. *Tonind.-Ztg.*, **55** [9], 124–25 (1931).—The breaking percentage of fire brick chiefly depends on (1) the manner of manufacture, transportation, and firing, (2) appropriate and expert methods of working, and (3) careful operation. Errors in the preparation of clays, in granulation, in the water content of separate materials, and in the use of clays of unequal plasticity, errors occurring during molding, and in charging the kiln with the ware are discussed. M.V.K.

Removal of iron from bauxite. HANS JORDT. *Tonind.-Ztg.*, **55** [5], 69 (1931).—Bauxite is heated to redness in a graphite crucible, mixed with coal tar, and reduced at a high temperature. The tar-coal-bauxite mass is treated with acids (dilute hydrochloric acid) in the absence of oxygen. The acids dissolve the iron which has changed into a soluble form on heating to redness with reducing flame (with the generation of hydrogen) and the iron solution is filtered off. When the product obtained is heated with oxidizing flame, it contains much less iron than the raw material. Some alumina is also lost. Bauxite free from iron is well suited for preparing highly-refractory basic blocks, even when it contains 10 to 12% silicic acid. These blocks are prepared with 50% refractory

plastic clay, 5% crystallized soda, 25% finely-ground "bauxite grog" (deferrized), 20% hydrate of alumina with a corresponding quantity of water, and the molded blocks are thoroughly fired. M.V.K.

Influence of atmosphere on load-bearing capacities of fire brick. H. T. S. SWALLOW. *Refrac. Jour.*, **6** [64], 148 (1931); for abstract see *Ceram. Abs.*, **10** [1], 41 (1931). E.P.R.

Testing refractories. C. P. FERNANDEZ. *Refrac. Jour.*, **6** [64], 148 (1931); for abstract see *Ceram. Abs.*, **10** [1], 38 (1931). E.P.R.

Tests of special refractory brick. I. OTTO KUKLA. *Blast Fur. Steel Plant*, **19** [2], 302–304 (1931); see also *Ceram. Abs.*, **10** [2], 124 (1931). E.J.V.

Manual for interpretation of refractory test data. J. SPOTTS MCDOWELL AND A.E.R. WESTMAN. *Proc. A.S.T.M.*, **30** [I], 478–504 (1930).—The standardization of test methods for refractories has been in progress for some time. Four standard and two tentative methods are listed in the current List of Standards of the A.S.T.M. and two other test methods are described in standard specifications. The methods of sampling, ways of reporting data, and the determination of the precision of results, however, have not received as much attention as they deserve. It is the purpose of this manual to discuss these phases of the testing of refractories and to give methods which, if generally followed, should greatly increase the usefulness of data on refractories. The procedures given in the manual have been based, insofar as possible, on well-established, modern statistical theory, and the symbols and definitions are those which are being adopted generally in work of this kind. R.A H.

Experimental research on the gas-permeability of ceramic products at high temperatures. PIERRE BRÉMOND. *Céramique*, **34** [514], 3–5 (1931).—After pointing out the importance of permeability from the practical viewpoint, B. reviews the work of Wologdine, Widemann, Cassan, Jourdan, etc., who verified Graham's Law for ceramic products at room temperature. Experiments are described in which the rate of air flow through a small, tight sagger was measured at twenty-two temperatures between 22 °C and 1230 °C. Taking the density of the gas to be inversely proportional to the absolute temperature, B. shows that his values differ very strikingly from Graham's Law, the permeability of the sagger decreasing rapidly with temperature. This is attributed to an increase in viscosity of the air. The conclusion is drawn that tight saggers are more effective in protecting ware from furnace gases at high temperature than would be calculated by extrapolation on Graham's Law. A.E.R.W.

Chemical investigations of refractory materials. III. H. J. VAN ROYEN AND HUBERT GREWE. *Arch. Eisenhüttenwesen*, **4**, 17–21 (1930); for abstract see *Ceram. Abs.*, **10** [3], 223 (1931). (*C.A.*)

Experiments in weathering plastic fire clays. STUART M. PHELPS AND C. G. DENNEY. *Jour. Amer. Ceram. Soc.*, **14** [4], 319–24 (1931).

Application of X-ray microscope for examination of clays and refractory materials. G. SHEARER. *Refrac. Jour.*, **6** [65], 151–53 (1931).—Rees and Chester of Sheffield University, working in collaboration with Bradley and Roussin of Manchester University applied the X-ray method to the study of the magnesia-zircon series. The method has certain advantages over the ordinary methods of chemical analysis. It is a nondestructive method and requires only a minimum of material. The analysis can be carried out, if necessary, at high temperatures and the nature of the results are peculiarly direct. It tells directly the state of chemical combination of the atoms and not merely the nature of the atoms present. The method is not one which will replace the existing methods; it is one which must be used in conjunction with them. E.P.R.

Manufacture and use of refractories in some European factories. R. M. KING.

O.S.U., *Eng. Expt. Sta. News*, **2** [8], 8–9 (1931); *Blast Fur. Steel Plant*, **19** [2], 301–302 (1931).—At the Schiedhauer & Giessing plant in Duisburg, fireclay, silica, chromite, and sillimanite refractories are made. A new process for making fireclay refractories consists of mixing about 10% clay in slip form with 90% grog. Large shapes are made by tamping, and small regular shapes by machines. Three types of refractories are made by this method, "Maxial," "Resistal," and "Vitral." "Maxial" is used in powdered coal furnaces, blast furnaces, burner blocks and muffles, retorts, etc. "Resista" is especially resistant to slag action and is used largely where molten baths come in contact with the refractories in glass tanks and enamel frit furnaces. "Vitral" is a refractory made primarily for glass tanks as it has the highest resistance to slag, especially soda slag. No shrinkage occurs in the process of manufacture. Another interesting product of this company is a silicon carbide tipped fireclay brick. Such a product can be used effectively as a substitute for silicon carbide at the "slag line" in boiler furnaces. The roofs of the open-hearth furnaces of the Ruhrort-Meiderich plant of the Vereinigte Stahlwerke last 500 to 600 heats as compared to good American practice of 300 heats. The top third of the checker setting consists of silica brick and the lower two-thirds of fireclay brick. The life of the checkers is from 1200 to 1600 heats. In Germany, open-hearth bottoms last about 3000 heats or about two years; in America about ten years. German open-hearth operation is more continuous; eleven tons are made per hour with the same equipment with which we make only seven tons per hour. The shorter bottom life and lower refractory consumption is due to the fact that they "make bottom" only once a week whereas we "make bottom" after each heat or about twice each day. The walls of German furnaces are 30 in. thick at the bottom and 24 in. at the top as compared to 18 in. at the bottom and $13^1/_2$ in. at the top in American furnaces. Roofs are about the same as in our own construction. For miscellaneous purposes such as ladle linings, stopper, and bottom brick, a refractory having a P.C.E. of 30 is used. American refractories used for similar purposes have a P.C.E. of 12 to 16. W.C.O.W.

Black Dinas brick in practice. P. P. BUDNIKOFF AND I. L. SMELJANSKY. *Ber. deut. keram. Ges.*, **11** [11], 575 (1930).—Results obtained with brick to which a certain amount of Martin furnace slag or other iron-containing slags were added are presented. The firing behavior, structure, and specific gravity were tested and it was concluded that 1% slag is a favorable addition to the Dinas mixture, causing formation of tridymite, increasing the density, and favoring the development of sharp edges and corners. To increase the porosity of black Dinas and to change the ferric oxide to ferrous oxide, a reducing agent is added. I.R.

Boiler-furnace refractory. REES. *Boiler House Rev.*, 594–96 (1930); *Refrac.-Jour.*, **6** [64], 148 (1931).—An extended review is given of the rapid progress made in the production and applications of boiler-house refractory materials during recent years. See following abstract. E.P.R.

Refractories for boiler furnaces. REES. *Iron & Coal Trades Rev.*, No. 1, p. 4 (1931); *Refrac. Jour.*, **6** [65], 184 (1931).—An account is given of the following: after-expansion, the thermal conductivity of brick, super-refractories, and jointing cement. R. states that though super-refractories are not especially resistant to the slagging action of ferruginous ashes in the presence of reducing gases, their high normal refractoriness, their marked volume stability, and mechanical strength on prolonged exposure to high temperatures renders them of great value in many boiler furnaces and especially in pulverized-coal and oil-fired furnaces. See also *Ceram. Abs.*, **9** [10], 852 (1930). E.P.R.

Shape of refractory blocks. HERAEUS. *Feuerfest*, **5** [6], 102–105 (1930).—Among the factors promoting the durability of refractory blocks H. discusses the effect of shape on the durability. M.V.K.

Removing deposits in rotary kilns. SCHEID. *Zement*, **19**, 963–64 (1930); *Pit & Quarry*, **21** [8], 70 (1931); for abstract see *Ceram. Abs.*, **10** [1], 60 (1931). E.P.R.

Casting refractories. W. EMERY. *Refrac. Jour.*, **6** [64], 148 (1931); for abstract see *Ceram. Abs.*, **10** [2], 119 (1931). E.P.R.

Improvements in dry-pressed refractories. R. E. BIRCH. *Refrac. Jour.*, **6** [65], 184 (1931); O.S.U., *Eng. Expt. Sta. News*, **2** [9], 6 (1931); see also *Ceram. Abs.*, **9** [10], 847; [12], 1054 (1930).

Structure of silica brick. G. L. CLARK AND H. V. ANDERSON. *Refrac. Jour.*, **4** [48], 398, 400 (1929); for abstract see *Ceram. Abs.*, **9** [5], 355 (1930). E.P.R.

Refractory cements. C. EDWARDS. *Refrac. Jour.*, **5** [52], 160 (1930); see also *Ceram. Abs.*, **9** [11], 942 (1930). E.P.R.

New hollow checker tile. PARKER-RUSSELL MINING & MFG. CO. *Brick Clay Rec.*, **78** [2], 72 (1931); *Fuels & Fur.*, **8** [12], 1686 (1930).—The advantages of these tile are increased weight per cubic foot of checker work, greater exposed surface per given volume, and a smaller percentage of area closed off. The tile are 14 x 12 x $5^1/_2$ in., with three 3 in. sq. openings. The ends are ground to assure uniform lengths, and parallel abutting surfaces. Illustrated. E.J.V.

New refractory announced. ANON. *Ceram. Ind.*, **16** [3], 294 (1931); *Brick Clay Rec.*, **78** [3], 170–71 (1931); *Clay-Worker*, **95** [2], 127 (1931); *Gas Age-Rec.*, **67** [7], 258 (1931).—A. P. Green Fire Brick Co. has developed a brick called "Mexco" to fill the gap between the highest-grade flint fireclay brick and the diaspore group. The company has issued a bulletin giving details of tests on the brick. W.W.M.

Refractories in 1929. ANON. *Blast Fur. Steel Plant*, **19** [2], 301 (1931).—Nine-inch equivalents were credited with a production of 954,490,000 brick, a figure well over 1928 and 1927. High-alumina brick almost doubled the production of 1928, with a 1929 output of 23,693,000 brick. Special refractory shapes reported a 1929 production of 143,434 T. compared with 86,671 T. in 1928. Silica brick production gained with 294,402,000 brick; magnesite and chrome brick gained with an output of 17,399,000 brick. E.J.V.

Developments in refractories in 1930. G. G. COOLIDGE. *Blast Fur. Steel Plant*, **19** [1], 160–62 (1931).—Certain refractories have not fallen in production because they are being adapted to numerous new services. The alumina contents of high-alumina refractories are 50, 60, 70, and 80%, each being adapted to a number of special services. They are used for lining firing zones of rotary cement and dolomite kilns, more recently in boiler settings and a variety of metallurgical furnaces. Economies resulting from the use of high-alumina checker brick warrant more extensive use. Power-press process from semi-dry batches is becoming more general. They have greater uniformity of size. Refractories more refractory than silica brick have been developed but when tried in open-hearth roofs have not proved practical because of spalling, squeezing under pressure, and deteriorating due to oxidation. Considerable research work has been done in developing better silica brick by using new types of presses, by sizing of the grains, and by blending ganisters. Caution must be used in selecting high-temperature cements because they differ in qualities. E.J.V.

Progress in the refractory field in France. OTTO PHILIPP. *Feuerfest*, **6** [11], 161–68; [12], 177–79 (1930).—P. discusses the development of the refractory industry in France for the years 1928–29, treating (1) kilns for firing refractory objects; (2) preparation of refractory products; (3) tests on (*a*) refractoriness, (*b*) softening at high temperatures, (*c*) strength, (*d*) thermal conductivity, (*e*) gas permeability, (*f*) expansion due to heat; (4) use of refractory materials in (*a*) firing chamber lining, (*b*) lime and cement kilns, (*c*) blast furnaces, (*d*) fireplaces; (5) special refractory products, *e.g.*, (*a*) dolomite and magnesite and (*b*) refractory mortars and cements. M.V.K.

Magnesia and magnesia block manufacture. FRIEDRICH REINHART. *Tonind.-Ztg.*, **55** [7], 94–97 (1931).—The mineral magnesite is the main constituent in the manufacture of refractory magnesia objects. Different products originate during firing of magnesite depending on the height of the firing temperature. These products differ in their capability of chemical reaction and their physical behavior. Caustic, reactive magnesia is obtained by heating magnesite to 700 or 1000°. When fired to 1450 to 1700°, magnesite vitrifies to a compact mass, depending on the content of impurities especially iron oxide and silicic acid. This sintered magnesia has a specific gravity of about 3.65 and is the main component of refractory magnesia blocks. These are fired in shaft kilns and annular kilns. B. describes the latest German and foreign patents for the preparation of magnesia products. M.V.K.

Ladle brick. ANON. *Refrac. Jour.*, **6** [65], 170 (1931).—Fire brick for use in steel ladles should never be selected for their refractability alone. Brick of high refractability, which do not vitrify at the ladle temperature, permit the entry of slag and are destroyed sooner than a less refractory brick. A high-grade infusible fire brick will not give such good results in a ladle as one of medium grade in which clays of suitable composition are blended to form a mixture which will sinter (or vitrify) when the brick is brought into service. This sintering forms a glass which coats the particles of refractory materials and fills the spaces between them preventing the penetration of the slag into the pores of the brick, and assisting it to resist corrosion for a longer period. The manufacturer of ladle brick should select a mixture of clays of the right chemical composition which will sinter to just the proper degree, without going too far and producing so much glass as to melt the particles of refractory material. E.P.R.

BULLETINS

Furnaces for various heat treatments. ANON. *Metal Prog.*, **18** [6], 156 (1930); American Gas Furnace Co., *Bull.*, No. B-9.—The requirements in hardening high-speed steel with reference to furnace equipment are discussed and various heating machines and rotary retort machines for carburizing are described. E.P.R.

Refractory cements. BOTFIELD REFRACTORIES CO. *Metal Prog.*, **19** [1], 142 (1931); for abstract see *Ceram. Abs.*, **10** [2], 126 (1931). E.P.R.

PATENTS

Producing alumina from aluminiferous substances. MAX BUCHNER. U. S. 1,792,410, Feb. 10, 1931. The method of producing pure alumina, which comprises treating aluminiferous material with nitric acid insufficient to combine with all the alumina in the material, separating the aluminium nitrate solution and dissociating the latter by heat.

Furnace arch and blocks. NICK T. PUCKETT. U. S. 1,792,446, Feb. 10, 1931. A block suspension member for furnace arches comprising a stem having a head at its lower end and a pair of bifurcated arms at its upper end, dogs pivotally mounted on the arms and normally extending toward one another at an angle to the arms and means on the dogs adapted to engage the arms to prevent the yielding of the dogs in but one direction.

Floor for kilns. VERNON C. PATTON. U. S. 1,793,129, Feb. 17, 1931.

Fire bridge, especially for transportable furnace plants. ULRICH BARSKE. U. S. 1,793,205, Feb. 17, 1931.

Ceramic materials. VEREIN FÜR CHEMISCHE UND METALLURGISCHE PRODUKTION. Fr. 687,174, Dec. 23, 1929. In the manufacture of ceramic materials of all kinds from plastic and nonplastic materials, the nonplastic constituent is mixed with an agent capable of dispersing or peptizing the plastic constituent before working the two together.

Thus, chamotte and quartz are dampened and impregnated with a solution of NH_3 or K_2CO_3 and then mixed with plastic clay, whereafter the procedure is as usual. Other examples are given. (*C.A.*)

Alumina. COLLOID-CHEMISCHE FORSCHUNGS A.-G. (Eugen Herzfeld and Hans Walker, applicants in Switzerland). Fr. 687,725, Jan. 6, 1930. Bauxite or other ores containing Al are heated with concentrated H_2SO_4. The sulphate is dissolved in water and $Al_2(SO_4)_3$ is precipitated free from Fe by adding alcohol. The $Al_2(SO_4)_3$ is transformed to Al_2O_3 by roasting. (*C.A.*)

Ceramic materials. VEREIN FÜR CHEMISCHE UND METALLURGISCHE PRODUKTION. Fr. 687,756, Jan. 6, 1930. In the preparation of ceramic materials from a plastic material and plastic binders in the form of colloidal solutions, the liquefaction of the binder is obtained by the use of a solution containing humic substances and NH_3 or NH_4 salts, and then working in known manner. (*C.A.*)

Terra Cotta

Strength tests on roof tile. NORMAN W. KELCH. *Proc. A.S.T.M.*, **30** [II], 783–93 (1930).—Fired-clay roofing tile are primarily a water-resistive covering for a roof. When such roofs are so located that the fall of broken or loosened tile would endanger life or limb below, then the quality and security of the roofing tile become a matter of legislation for public safety. The object of this investigation was to determine a fair and adequate method of testing roofing tile which would truly indicate their quality with respect to probable permanency and security, bearing in mind the thought that the test method should be one which could be incorporated in building codes. Many tests were made on flat Italian pan tile and flat shingle type tile by supporting them horizontally upon four contact points of bearing near the corners. A load was applied to the center of the tile. The loads on the flat tile varied widely according to their thickness and composition. One set of about 30 tests averaged 275 lb. breaking load on flat shingles with a spread from 159 to 399 lb. Another series of Italian pans with 90° flanges averaged about 375 lb. with a spread from 240 to 480 lb. Another series of shingle tile had an average of 350 lb. with a spread from 195 to 560 lb. A series of Italian pans with the flanges turned up about 45° showed an average of about 420 lb. with a spread from 390 to 475 lb. The Clay Products Institute of California is programming additional study on roofing tile in the nature of permeability tests and toughness tests, the latter involving impact or shock tests. See also *Ceram. Abs.*, **10** [3], 190 (1931). R.A.H.

Defective roof tile. ANON. *Master Builder*, No. 825, p. 50 (1930); *Tonind.-Ztg.*, **55** [14], 206 (1931).—Clays too lean produce permeable roof tile as do coarse clays. Fine clays produce tile with such small pores that water will not penetrate. Herein lies the difference between porous and permeable roof tile having the same degree of porosity. The size of the pores is decisiye. The manufacturing difficulties are described. M.V.K.

Moisture expansion of glazes and other ceramic finishes. H. G. SCHURECHT AND G. R. POLE. *Jour. Amer. Ceram. Soc.*, **14** [4], 313–18 (1931); see also Bur. Stand., *Tech. News Bull.*, No. 166, p. 16 (1931).

Enameling brick. ANON. *Brick Clay Rec.*, **78** [4], 197–200 (1931).—A detailed description of all the processes and equipment used in the production of enameled brick at the Sayre & Fisher Brick Co. plant at Sayreville, N. J., is given. Illustrated. E.J.V

Colored aluminum; a possible competitor to clay products. ARTHUR D. LITTLE.

Brick Clay Rec., **78** [3], 131 (1931).—Indication that the metal manufacturers are seriously considering the possibilities of their products in the building field is found in the report that aluminum may be changed to any one of many shades of color. E.J.V.

Recent architectural developments in North America. W. FIELDING. *Art in N.Z.*, **3**, 140–44 (1930).—In no part of the world has science been applied to building with greater success than in the U.S. Color and texture are freely used both internally and externally by the employment of tile, stone, metals, and inlay wood. H.H.S.

Colonial design embodied in new Northern Pacific station. LOWRY SMITH. *Railway Age*, pp. 227–28 (Jan. 24, 1931).—The Northern Pacific employs a Colonial design in the construction of a passenger station and a restaurant building at Mandan, N. D. (*D.I.*)

BOOK AND BULLETIN

Amerika. RICHARD J. NEUTRA. Schroll, Vienna, 1930. About $5.00. Vol. II. A description of architecture in the U.S. is given with 260 illustrations. See also *Ceram. Abs.*, **10** [4], 279 (1931). (*D.I.*)

Perma-Chrome Glazes. CLAYCRAFT MINING & BRICK CO. *Brick Clay Rec.*, **78** [3], 135 (1931); *Clay-Worker*, **95** [2], 123 (1931).—There are 27 standard shades available in various effects such as mottles in light shades with rippled finish, mottles in darker shades with rippled finish, mottles in stippled finish, white with rippled finish, light colors in clear shades with smooth finish, darker colors in clear shades, and variegated colors. A list of color combinations that have proved exceptionally harmonious is offered. "Perma-Chrome Glazes" are available in standard brick and craft sizes. The bulletin illustrates the 60 standard shapes and 54 craft size shapes offered. E.J.V.

White Wares

Reversible expansion of clayware. VII. TOSAKU YOSHIOKA. *Jour. Jap. Ceram. Assn.*, **37** [433], 1–18 (1929).—Thermal expansion of bodies composed of ground quartz and the five clays described in the previous report has been measured. The effects of temperature and time of the previous heat treatment, fineness of the quartz, porosity of the bodies, and the proportion of the two materials on the expansion are described. Conclusions are as follows: (1) An additive nature of clay and quartz has been ascertained in the expansion, though the actual values are smaller than the theoretical. The difference varies with the fineness of quartz. (2) The bodies fired at lower temperatures show abnormal expansion due to the presence of quartz, while those fired at higher temperatures show the quartz effect or the cristobalite-tridymite effect except the body made of Tokiguchi Gairome and quartz and fired at 1500°C for four hours. (3) Any decrease in the porosity of a body causes a slight increase in its reversible expansion. (4) A marked increase in the expansion is brought about by grinding the quartz finer. (5) When the fineness of quartz is the same, the expansion grows with the increase of quartz. Similar experiments have been carried out with bodies composed of two parts of the clays and one part of amorphous silica prepared by decomposing water glass with HCl with the results that (*a*) no quartz effect is indicated; (*b*) bodies fired at temperetures over 1200° show cristobalite-tridymite effect; and (*c*) the normal and abnormal expansions of the clay-quartz bodies are lowered by substituting amorphous silica for quartz. **VIII. Clay-feldspar body.** *Ibid.*, **37** [435], 77–84 (1929).—The reversible expansion of bodies of two parts clay and one part feldspar is discussed. Kaolins of Zettlitz and Katogun, and Gairome clays of Seto, Tokiguchi, and Seikirei are used. Analyses of the feldspars are silica 71.82, alumina 14.92, ferric oxide trace, lime 0.42, magnesia 0.41, potash 14.26,

and water 0.24. Fineness as determined by means of Schoene's elutriator is as follows: under 0.2 mm. flow 52.75, 0.2 to 0.7 mm. 26.07, 0.7 to 1.5 mm. 11.02, fine sand 3.27, and coarse sand 5.01. Results: (1) The expansion of the clay-feldspar bodies varies in narrow ranges regardless of the difference in the previous heat treatment. (2) When test pieces are fired at low temperatures, *i.e.*, 900°C, the expansion of the clays is increased by the addition of the feldspar. (3) Previous firing at high temperatures, *i.e.*, 1300° or 1400°, does not cause an excessive high expansion. The feldspar acts rather to decrease the expansion of the clays. (4) Feldspar diminishes or ceases the quartz effect. (5) It makes the tridymite or cristobalite effect disappear. (6) It tends to make the temperature expansion curves straight. (7) The expansion of fused feldspar is comparatively low and straight. **IX. Bodies composed of clay, quartz, and feldspar.** *Ibid.*, **37** [436], 135–56 (1929).—The effect of variation in the heat treatment and the composition of clay-quartz-feldspar bodies on their thermal expansion was determined for various mixtures. The results are as follows: (1) Temperature of previous heat treatment. (*a*) The expansion is not high in those bodies which have been heated to temperatures as low as 1000°C, owing probably to their high porosity. (*b*) The highest expansion is observed in bodies heated at 1200°. At such a temperature, most of the quartz grain remains undissolved while the porosity decreases. (*c*) Expansion of the bodies heated at 1300 to 1400° is low. The quartz effect is moderate and the temperature-expansion curves are smooth though not regular. (*d*) Expansion of the bodies heated at 1500 to 1550° is lowest. No quartz effect is observable. (*e*) The bodies treated at the high temperatures show no tridymite or cristobalite effect, probably due to the dissolving action of feldspar. (2) Duration of previous heat treatment. An expansion of the time exerts a similar effect caused by a small increase in the temperature. (3) Atmosphere. In temperatures above about 1200°, an atmosphere of H_2 or CO is most effective in lowering the expansion. The phenomenon is more marked in stoneware than in porcelain. (4) Fineness. (*a*) Fine grinding of quartz lowers the temperature of the previous heat treatment by which the expansion is reduced and is made regular. (*b*) With coarse quartz grain, the expansion remains high as long as it is not vitrified. (*c*) If a body has been heated long at sufficiently high temperatures, a same low regular expansion will be reached regardless of the fineness of quartz. (*d*) When powder of quartz glass is used instead of quartz, porcelains with low regular expansion are obtained regardless of the intensity of the heat treatment. (*e*) Porcelains made of clay, feldspar, and precipitated silica show comparatively low regular expansion. (*f*) With sufficiently high long heat treatment, the expansion of bodies with the same silica content reaches a practically low value and becomes regular. **X. Abnormal expansion of clayware due to weathering.** *Ibid.*, **37** [437], 189–93 (1929).—A study was made of the abnormality in the expansion of fired clay and porcelain biscuits due to weathering. Test pieces made of Zettlitz kaolin or Gairome clays and fired at 900°C for one hour and those made of a porcelain body and fired at temperatures ranging from 1200 to 1550° for one hour, were treated in an autoclave for 44 hours and then tested for their thermal expansion. All test pieces made of the clays and that of the porcelain body which were heated at 1200° show marked contsaction between 200° and 500° in the first heating, while the porcelain pieces heated at 1300° and up indicate no permanent contraction. **XI. Discussion of some properties of clayware related to thermal expansion.** *Ibid.*, **37** [439], 267–81 (1929).—Conclusions of thermal expansion of clayware are as follows: (1) Effect of previous heat treatment on the abnormality in the expansion of high-grade clays. (*a*) Below 1200°; expansion-temperature curve straight; (*b*) 1300° and 1400°; abnormality at temperature below 250°; (*c*) 1500°, practically straight. (2) Same on the amount of the expansion. About 900 to 1100° low; 1200 to 1300° high; and 1500° low again. (3) Effect of quartz in clays. The quartz increases

the expansion and causes abnormal expansion at about 575°. (4) Effect of replacing quartz with precipitated silica. (*a*) Abnormality at about 575° is avoided. (*b*) The expansion is lowered. (*c*) Heat treatment at temperatures over 1200° causes the abnormality at temperatures below 230°. (5) Addition of feldspar. (*a*) Similar expansion is shown by a body regardless of the difference in firing temperature. (*b*) Bodies fired at 1300° or 1400° do not show the abnormal high expansion due to tridymite or cristobalite. (*c*) Abnormality due to quartz is reduced or nullified. (6) The expansion of clay-feldspar-quartz bodies. (*a*) When fired at comparatively low temperature, *e.g.*, 1200° or under, expansion is low and the abnormality due to quartz occurs. (*b*) When fired at medium temperatures, the abnormality due to quartz is severe and the expansion is highest. (*c*) When fired at higher temperature, the expansion is low and the curve is smooth though not regular. (*d*) When fired at still higher temperatures, the abnormality disappears and low, straight expansion is shown. (7) Fine grinding of quartz causes higher expansion as long as the body is not melted. (8) An increase in the porosity of a body reduces its expansion slightly. (9) Clayware fired at low temperatures is apt to expand by the absorption of moisture. Descriptions are given of the theoretical consideration on the results of the experiments, thermal endurance, the safe heating and cooling rate of clayware, crazing and shivering of glazes, significance of total analysis of potteries, etc. For Parts V and VI see *Ceram. Abs.*, **8** [9], 682 (1929). S.K.

Fusibility and capability of resisting of porcelain glazes. F. ZAPP. *Repts. Czechoslo. Ceram. Soc.*, **7** [1–2], 25–38 (1930); *Sprechsaal*, **64** [5], 93 (1931).—The influence of firing and of the proportion of Al_2O_3:SiO_2 on the appearance of glazes and other properties was determined on 60 different glazes with a constant proportion of fluxes 0.3 K_2O :- 0.7 CaO. The various glazes were recorded on diagrams according to their alumina and silicic acid content for different firings, and their qualities defined. The range of usable glazes shifts with increased firing from soft to hard glazes, but it is remarkable that a whole series of different glazes could be used at all the temperatures applied (Seger cone 11, 13, 14, and 15). In order to obtain and retain the state of a homogeneous glaze, the oxygen combined with Si must be in a fixed proportion with the oxygen combined with the bases; the acid number, $S = \frac{SiO_2 \cdot 1}{RO \cdot 1R_2O_3 \cdot 3}$, had the best values between 2 and 2.25 in the glazes investigated. The important influence of the paste composition was determined and recorded on a diagram but not investigated further. The capability of the flow of the glazes and their cone of fusibility was determined; the equidistant flow of several glazes, which is conditioned by the equal viscosity of the glaze flux at the temperature used, is not identical with an equal cone of fusibility of glazes. The slower the temperature is increased, the nearer these approach each other. The glazes were scratched with a diamond under fixed pressure to determine their capability of resisting, and the scraper was microscopically investigated and measured. No definite relationships could be ascertained between the width of the streak and hardness of the glaze except possibly on the basis of the influence of the tension between the glaze and the body and the degree of fusing and clarifying of the glaze batch. Firing greatly affects the fissure hardness of glazes, but Z. could not give clear numerical values. It was determined that the capability of resisting of glazes depends, first of all, on the degree of fusing and on their adhesion without tensions to the bodies. M.V.K.

Determination of mullite content in porcelain by chemical means and relation between determined mullite content and properties of the porcelain. R. RIEKE AND W. SCHADE. *Ber. deut. keram. Ges.*, **11** [8], 427 (1930).—Conditions were examined under which it is possible to isolate mullite from porcelain by hydrofluoric acid and to get reliable data. The influence of temperature of the hydrofluoric acid, its concentration, and the time of the treatment have been tested and a method developed. Only

when working under exact conditions, *e.g.*, keeping the room temperature absolutely constant, is it possible to get good results. The influence of the mineral composition, the firing temperature, and the time on the mullite content have been tested for a number of porcelains with 40 to 60% clay substance, 15 to 35% quartz, and 15 to 35% feldspar. The authors tried to develop the relation between the mullite content of the porcelain and its specific gravity, and also a relation between mullite content and strength of the porcelain. It is possible to check back on the mullite content as the specific gravity will be lower for material fired higher and longer. The quality of the porcelain does not depend on its mullite content as far as mechanical properties are concerned. Furthermore, technical porcelain was tested for mullite content and conclusions were drawn on the firing temperature and other conditions. It was not possible to develop a connection between mullite content and the different mechanical properties of such porcelain. They also tested the influence of different kaolin on the mullitization of the porcelain. Kaolin of Crosta developed, under normal conditions, the largest amount of mullite. There is no relation between the quantity of mullite and the transparency of porcelain. I.R.

Aging and non-aging ceramic bodies. FELIX SINGER. *Keram. Rund.*, **38**, 167–71, 183–87, 216–22 (1930).—The repeated heating and cooling of porcelain may bring about failure due to three causes: (1) the different coefficients of thermal expansion of the crystalline constituents and of the glassy constituents of the body, leading to rearrangement in position of the grains of the different constituents in the body; (2) the gradual crystallization of the glass leading to the introduction of new crystalline constituents with different expansivities; (3) strains set up due to different expansivities of glaze and body. The mullite, quartz, and glass in a body differ in expansivity among themselves and from that of the body. The transition from low-temperature to high-temperature quartz with a corresponding abrupt change in thermal expansion creates additional stresses in the body which are avoided by firing the body to such a high temperature that the quartz is completely dissolved in the glass. Disruption due to dissimilar expansivities of glaze and body may be avoided by using glazes with high elastic limits and high strength. The production of an ideal porcelain for all purposes is impossible but the most satisfactory general purpose porcelain is one composed of a homogeneous unstrained and isotropic glass in which are embedded a great number of fine mullite crystals matted together. Ordinary porcelains are of necessity heterogeneous and consequently show some aging tendency. "Steatite" porcelain, however, consists of only one constituent, "enstatite," and therefore shows no tendency to fail by aging or fatigue. In all important properties except thermal expansion, "steatite" porcelain is superior to ordinary porcelains. Decreasing the thermal expansion by increasing the content of Al_2O_3 causes the formation of a glassy and another crystalline phase and makes the material susceptible to aging. Compounds of Ce, Zr, Cr, Mn, P, Wo, and V especially when combined with Ti compounds appear to have a beneficial effect in porcelains since they act as mineralizers and induce the crystallization of the glassy phase during the firing or cooling instead of permitting the crystallization to occur at a later time resulting in the failure of the body. H.I.

Comparison of bodies containing blended feldspars and one mine feldspar of similar composition. C. W. PARMELEE AND C. R. AMBERG. *Jour. Amer. Ceram. Soc.*, **14** [4], 309–12 (1931).

Effect of different fluxing oxides on the constitution of porcelain. A. H. FESSLER AND H. NAVRATIEL. *Ber. deut. keram. Ges.*, **11** [6], 364 (1930); see also *Ceram. Abs.*, **9** [6], 443 (1930). I.R.

Preventing water stain in dinnerware. G. A. BOLE. O. S. U., *Eng. Expt. Sta. News*, **2** [9], 2 (1931).—In the manufacture of dinnerware, some of the decorations are

applied by a transfer process with a transfer material known as "decal" paper. After the decal paper has been washed off, the ware is usually sponged to remove all water spots. Frequently, however, some drops of water are left on the ware and when those evaporate they leave a residue which burns into the ware in the decorating kiln. The effect is a devitrified blur on the glaze. B., research professor of the Eng. Expt. Sta., has recently developed a process which not only eliminates the expense of sponging or wiping the ware to prevent water spots but guarantees against formation of any such spots. The process consists of washing decorated dinnerware in a solution of saponin (1 part to 4000 parts of water) as it comes from the decal machines. If used in the tank of a machine, the solution gives trouble with foaming; it has been found advantageous, therefore, to add a small amount of defoaming agent such as Turkey-red oil to the saponin solution.

Frost stability of whiteware wall plates. A. LISSNER. *Repts. Czechoslo. Ceram. Soc.*, **7** [1–2], 79–83 (1930); *Sprechsaal*, **64** [5], 93 (1931).—Whiteware wall plates of good quality (porosity about 16%) were damaged by excessive cold. Irregular pieces of the glaze and body of the plates about 5 mm. in thickness broke off. Investigations showed the presence of water in the pores of the plates. Repeated thawing and freezing and the subsequent changes in volume of the plates had produced the tensions which caused the damage. M.V.K.

Acid resistance of on-glaze colors. R. RIEKE AND L. MAUVE. *Ber. deut. keram. Ges.*, **11** [9], 487 (1930).—One hundred and seventy-five samples of different colored on-glaze colors used in painting glazed porcelain plates with the different materials delivered from different manufacturers were examined. The plates were fired after the painting at about 790°. One plate of each color was placed in 50 cc. of 4% acetic acid at room temperature for 24 hr., another for 2 hr. into 0.75% hydrochloric acid, and another into the same solution for 5 hr. After the treatment the plates were washed and their appearance noted. The water acid solution was treated with H_2S gas and the quantity of Pb determined, often only by stating "much," "nothing," or "little." The material collected is given in tables. The authors state that the test with acetic acid proved the best and most efficient for practical use. Among each color are some which stood the test well. They want the producer to test their colors for chemical resistance before putting them on the market, in order to prevent complaints. I.R.

Underglaze as solution to sanitary ware problem. W. W. WILKINS. *Ceram. Ind.*, **16** [3], 278–79 (1931).—W. discusses the difficulty of obtaining colors on vitreous sanitary ware which match the enamelware colors. This is because of the longer and higher fire necessary in the production of the former. He suggests the use of an underglaze for coloring the vitreous ware, a method used successfully on general ware in European plants. It is suggested that the enamelware producers should adopt the colors possible of production on the vitreous ware and that there should be more coöperation between the stain manufacturers and the sanitary ware plants. The adoption of standard shades of colors and standard stains with numbers is urged. W.W.M.

Standardize sanitary ware colors. ANON. *Ceram. Ind.*, **16** [2], 112–13 (1931); *Amer. Enameler*, **4** [1], 5–6 (1931).—The Manufacturers Advisory Committee on Colored Sanitary Ware unanimously adopted green, orchid, ivory, blue, light brown, and black as standard colors for sanitary ware. W.W.M.

Influence of alkaline cleaners on the resistance of underglazed colors. E. KILLIAS. *Ber. deut. keram. Ges.*, **11** [11], 602 (1930).—Ordinary underglazed colors do not withstand treatment in mechanical "dishwashers" working at a temperature of 80 to 100°. It is not sufficient to test underglaze color by the acid test. The following method is better: Boil one piece for 50 hr. in 10% solution of "M" cleaner, place another piece for 5 hr. into a solution of 3% hydrochloric acid at room temperature, place another piece

into the same solution for 50 hr., and another piece for 5 hr. into 5% soda solution, also at room temperature. I.R.

Answer to article of E. Killias. (See preceding abstract.) R. RIEKE. *Ber. deut. keram. Ges.*, **11** [11], 607 (1930).—R. does not believe that the treatment given by K. is "normal" but far too strong. If the cleaners used in this testing method take the glaze off, the porcelain manufacturer cannot be held responsible if the colors are ruined. I.R.

Using borosodium calcite instead of borax in glazes. M. SOLOMONOV. *Ceramics & Glass*, **6** [11–12], 527–28 (1930).—S. describes tests made to use borosodium calcite ($5B_2O{\cdot}CaO{\cdot}Na_2O{\cdot}12H_2O$) instead of borax in frits for glazes. The glazes obtained were found good. M.V.K.

Gas permeability of ceramic pyrometer tubes and its relation to temperature. IMMKE. *Tonind.-Ztg.*, **55** [10], 149 (1931).—I. describes tests made to ascertain the dependence of the gas permeability of different kinds of pyrometers on temperature. The results are tabulated and show that the gas permeability decreases considerably with increase of temperature. M.V.K.

A C Spark Plug Co. ANON. *Ceram. Ind.*, **16** [2], 122–34 (1931).—A brief history of the A C Spark Plug Co. is presented, followed by a description of the present plant, manufacturing process, and equipment. Illustrated. W.W.M.

Preparing slip. J. WINKEL. *Tonind.-Ztg.*, **55** [5], 66–68 (1931).—W. describes several modern German installations for preparing slip. Illustrated. M.V.K.

Rationalization and standards in the ceramic industry. EBERHARD HERFELDT. *Sprechsaal*, **64** [3], 43–44 (1931).—H. discusses rationalization and its development, German standard specifications for sanitary white ware, household porcelain (dishes and cups), and wall and mosaic plates. M.V.K.

How Germany uses lithium and its compounds. W. T. DAUGHERTY. *Chemicals*, **35** [2], 29 (1931); for abstract see *Ceram. Abs.*, **10** [4], 281 (1931). G.R.S.

Leigh dinnerware. HELEN ROBERTSON. *Cleveland Plain Dealer*, No. 90, p. 46 (1931).—A brief nontechnical description of the processes followed in the production of tableware, as observed in use at the Leigh Potteries of Alliance, Ohio, is presented for the layman. A typical pattern of this ware is illustrated and discussed. E.J.V.

First American chinaware. HELEN ROBERTSON. *Cleveland Plain Dealer*, No. 90, p. 60 (1931).—The struggles of the famous American potter, Walter Scott Lenox, in producing the famous Lenox china are traced in this brief historical sketch. The change from china to the present Belleek ware and its choice for the White House dinner set by President Wilson are discussed. Some patterns of Lenox ware are illustrated and described. E.J.V.

Story of the English potter. HARRY BARNARD. *Pottery Gaz.*, **56** [644], 270 (1931).—B. deals with the first pottery made by man, the influence of and introductions by invaders of England, the Tudor and the Stuart periods, the Georgian development, the birth of the industry in Staffordshire, its spread throughout England with the discovery of new materials, and its rapid progress during the last century and a half. In describing the making of pottery B. dealt with the raw materials and their preparation and described the processes, such as throwing, turning, pressing, casting, modeling, painting, firing, etc. E.J.V.

PATENTS

Topping pottery. DAVID L. ROULEAU. U. S. 1,792,036, Feb. 10, 1931. A machine for topping pottery comprising a rotatable chuck adapted to hold an article of pottery having an edge of rounded cross-section, a tool holder mounted to move axially of the chuck, a tool of concave-convex cross-section supported by the tool holder and having its longitudinal axis extending at an inclination to the plane of rotation of the edge, the

inclination being such that the concave portion of the tool conforms to the rounded cross-section of the edge.

Multiple-skirt insulator. KENT A. HAWLEY. U. S. 1,794,111, Feb. 24, 1931.

Electric insulation. SIEMENS & HALSKE AKT.-GES. Brit. 339,726, Feb. 4, 1931. In order to avoid the formation of aluminium carbide, shaped insulating bodies, in particular spark plugs, formed by the vitrification of aluminium oxide, the heating process is carried out in an electric furnace free from carbon parts, and in a vacuum or atmosphere free from reducing gases or vapors containing carbon. An example given of such an atmosphere is one containing 3 parts of nitrogen to one part of hydrogen.

Ceramic insulators. JOSEPH L. A. HILBRENNER. Ger. 504,869, Oct. 13, 1926. In the manufacture of these, clay, kaolin, alumina, ZnO, and ZrO_3 are used with a flux or binding material formed by sintering together MgO, ZnO, and Al_2O_3. (*C.A.*)

Equipment and Apparatus

Selection of power machines for brick plants. LAASER. *Tonind.-Ztg.*, **55** [14], 198 (1931).—L. discusses the advantages and disadvantages of steam power installations, combustion engines, and the electric energy used in brick plants and concludes that (1) steam power installations permit the utilization of great quantities of waste heat in an easy way, power is obtained with small heat expenditure, and flue gases are utilized; (2) the combustion engines have immediate operation and little waste of heat; and (3) electric energy affords immediate operation with no waste heat and is comparatively cheap. M.V.K.

Portable brick- and tile-cutting unit. DEWALT PRODUCTS CORP. *Brick Clay Rec.*, **78** [3], 170 (1931).—This equipment for cutting brick and tile on the job is direct driven, and a totally enclosed, dust protected, and water protected motor, operating 1750 r.p.m., either 4 or 8 h.p. is employed. It is adapted to cut common and face brick, hollow-glazed tile, floor tile, glazed brick, roofing tile, terra cotta, etc. Illustrated. E.J.V.

Improved brick wrapper. E. J. SCHARIO. *Brick Clay Rec.*, **78** [3], 164 (1931); *Clay-Worker*, **95** [2], 121 (1931).—Each individual brick is covered on one side, one edge, and one end with a cushion of indented felt paper or other soft material, its other three contiguous surfaces being protected by similar wrappings on other brick piled against it. Tests in service have proved that this shield protects the luster of the brick. Illustrated. E.J.V.

Power consumption in brick plants.* J. OTIS EVERHART. *Brick Clay Rec.*, **78** [2], 94 (1931).

Automatic temperature control. PAUL MAEHLER CO. *Gas Age-Rec.*, **67** [10], 368 (1931).—A positive automatic control, combining temperature requirements with oven safety, has been developed. In the 20 x 16 x 5 in. cabinet are assembled the various devices providing automatic control, including the main switch, fuses, temperature control valve, the automatic mercury actuator, a gas-pressure controller, high-voltage transformer, time daily control, and red and green flasher lights which indicate the operation at all times. Illustrated. E.J.V.

American apparatus for measuring and for automatic regulation of temperature. H. ILLIES. *Messtechnik*, **6** [11], 299–303 (1930).—After enumerating the advantages of exact temperature measurement, I. describes the various recording thermometers, potentiometric instruments, and automatic temperature regulators which are produced by

* Paper presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Cleveland, Ohio, February, 1931. When this paper is published reference will be given.

such firms as the Brown Instrument Co., Leeds & Northrup Automatic Temperature Control Co., and the Cambridge Instrument Co. Illustrated. E.J.V.

Measurement of surface temperatures. ANON. *Messtechnik*, **6** [12], 329–30 (1930).—The Pyro surface pyrometer is described. This apparatus, made by Pyro-Werk Rudolf Hase, Hannover, depends on a strip of two dissimilar metals, with a junction at its center, stretched across a bow-shaped holder so that it can be placed against the surface whose temperature is being measured for its thermocouple and the temperature is read direct on a dial mounted on the handle. Illustrated. E.J.V.

Temperature regulator shifts automatically. ANON. *Elec. World*, **97** [3], 168 (1931).—A new temperature regulator for industrial heating systems is being marketed by the Stat-Omatic Instrument and Application Co., Hartford, Conn. It is equipped with an electric motor-wound clock, is fully automatic in operation, and has a dual thermostat which maintains the desired temperatures day and night and automatically shifts from day to night temperatures and vice versa. Week-end and holiday reductions of temperature are also automatically provided. G.R.S.

Instruments that simplify process control. Temperature control. ANON. *Chem. Met. Eng.*, **36** [4], 237–45 (1929).—A detailed description is given of thermometers, pyrometers, temperature regulators, and pressure, vacuum, and fluid flow controls. A useful chart shows the relation of these instruments. G.R.S.

Control of temperature in glassworks. M. G. STEPANENKO. *Ceramics & Glass*, **6** [11–12], 513–17 (1930).—S. discusses the importance of the control of temperature in glassworks, and describes thermoelectric, optic, and radiation pyrometers. M.V.K.

New device cleans broken glass. ANON. *Amer. Glass Rev.*, **50** [19], 15 (1931).—This new machine is a combination washer and magnetic separator. It cleans the cullet and removes all foreign matter, especially iron and steel scraps. It has a capacity of from 3 to 6 T. per hour, depending upon the amount of dirt to be extracted. E.P.R.

Expansion measurements of several glasses by means of a self-registering apparatus. WILLI M. COHN. *Jour. Amer. Ceram. Soc.* **14** [4], 265–75 (1931).

New comparator for expansion measurements of solid bodies up to 1400°C. WILLI M. COHN. *Z. Instr.*, **50**, 198–204 (1930); see also *Ceram. Abs.*, **10** [1], 71 (1931). H.I.

New comparator for dilatometric examinations of ceramic materials, etc. ERNST LEITZ CO. *Messtechnik*, **6** [6], 173–74 (1930).—This apparatus is used for the measurement of expansions of bodies which are heated in a furnace. Readings are taken through the comparator on reference marks on the test specimens in the cold and in the heated condition and the difference between the two standards is read directly on the drum of the ocular micrometer in 0.001 mm. A detailed description of the set-up necessary for making the determinations with this instrument and directions to be followed in making the test are given. Illustrated. E.J.V.

New rotary driers and kilns. ANON. *Pit & Quarry*, **21** [9], 96–97 (1931).—The Struthers-Wells Co., Warren, Pa., has just announced a new line of Timken-equipped rotary driers and kilns. This line includes all sizes from 2 ft. 6 in. to 10 ft. 7 in. diameter and lengths from 20 to 200 ft. or more, as conditions demand. They may be supplied for pulverized-coal, gas, or oil firing. E.P.R.

Transportation in the kiln house. G. HELM. *Ber. deut. keram. Ges.*, **11** [11], 588 (1930).—Based on time studies and studies of actual cost, H. favors, for larger plants, a circular transport. He explains how to modernize an old plant, how to save labor, and how soon the new equipment will be amortized. I.R.

New hydraulic pump for tunnel kiln car pushers. RICHARD DUDGEON, INC. *Brick Clay Rec.*, **78** [3], 169–70 (1931); *Ceram. Ind.*, **16** [2], 214 (1931).—The feature of this new hydraulic pump is the adjustment of the stroke of the pistons, permitting variation in volume of delivery. E.J.V.

Flue dust returned to rotary kiln by feeder. ANON. *Pit & Quarry*, **21** [11], 95 (1931).—The object of the Minogue flue-dust feeder, manufactured by Manitowoc Engineering Works, is to return the flue dust to a wet-process rotary kiln underneath the load in the kiln at a point from the feed and where the entering material has been thoroughly dried. This is accomplished in a simple manner, making cement from material which would otherwise be thrown away, or entered into the feed end of the kiln, thus interfering with proper operation. E.P.R.

Compressed air used for removing dust in stone. OSKAR KAMPHENGEL. *Steinind.*, **25** [10], 348–49 (1930); *Pit & Quarry*, **21** [8], 70 (1931).—K. in this article describes a device invented by himself for removing the dust from smaller sizes of crushed stone by means of compressed air thus producing a material practically free from the dust-fines which cannot be removed in the usual screening process. E.P.R.

Photoelectric control equipment. GENERAL ELECTRIC CO. *Glass Ind.*, **12** [2], 29 (1931).—Among the new developments in 1930 is the use of photoelectric control equipment. Its industrial application has progressed sufficiently to warrant the establishment of a line of photoelectric devices and accessories. Another new development is de-enameling equipment for operating a process for removing the vitreous enamel from defective parts. This was perfected and placed in successful operation during the year. E.J.V.

Electro-viscometer. ANON. *Ceram. Ind.*, **16** [3], 294 (1931).—The DeVilbiss Co. has a viscometer which works on the principle of viscous resistance, the viscosity being read on a dial showing the amount of power required to rotate a portion of the instrument which is lowered into the slip. W.W.M.

Migos-apparatus for p_H measurement by electrometric methods. ANON. *Messtechnik*, **6** [10], 291 (1930).—The various apparatus, including a potentiometer of a special type, used in making p_H determinations electrometrically as supplied by M. J. Goldberg & Sons, of Berlin, is described. Illustrated. E.J.V.

Meter for testing roundness and size. ANON. *Brass World*, **27** [2], 36 (1931).—Roundness and size of objects from $^3/_4$ in. to 6 in. in diameter may be checked with a new type of apparatus placed on the market by the Automotive Maintenance Machinery Co., Chicago, Ill. The new device is a direct-reading indicator which gives readings to half-thousandths of an inch. It is known as the "Ammco Round-O-Meter." E.P.R.

Simplified apparatus for extraction of liquids. R. B. FORSTER. *Chem. & Ind.*, **50** [3], 44 (1931).—Drawings and a description are given of an apparatus suitable for extraction of aqueous solutions by means of less dense nonmiscible solvents. G.R.S.

Manufacture of capillary tubes. M. A. BESBORODOV, E. A. KHVASS, AND M. F. SHUR. *Ceramics & Glass*, **6** [11–12], 506–13 (1930).—The difficulties encountered during the manufacture of capillaries for thermometers and their preparation in the "Droushnaya Gorka" plant are described. M.V.K.

Ball mills. J. WINKEL. *Tonind.-Ztg.*, **55** [12], 170–71 (1931).—W. describes a new ball mill with a large output, for pulverizing brick lumps, grog, lime, coal, and slag. M.V.K.

Ball-mill studies. II. Thermal determination of ball-mill efficiency. A. W. FAHRENWALD, G. W. HAMMAR, HAROLD E. LEE, AND W. W. STALEY. *Mining & Met.*, **12** [291], 17 (1931).—The published calculations of several investigators give very low absolute efficiency values for ball-mill comminution. These figures vary from less than one per cent to several per cent. All of these calculations are based on the use of a surface energy value for the material in question and on total surface produced in the reduction operation. Both of these data are of doubtful reliability. This paper presents a method of determining relative ball-mill efficiency based on thermal measurements that involves neither of these data. It is simple and direct. By this method, much higher

relative efficiency values for laboratory ball-mill batch grinding were obtained. Under a new set of ball-mill conditions, as high as 25% efficiency was recorded. Efficiency determinations based on thermal measurements also show the large improvement in the grinding capacity of a given mill when operated above critical speed and with small ball loads. For Part I see *Ceram. Abs.*, **10** [4], 283 (1931). E.J.V.

Electric shovel truck. ANON. *Chem. Met. Eng.*, **38** [2], 106 (1931).—The machine is small enough to operate inside a box car and yet is said to be capable of digging and carrying 1-ton loads. The traveling speed of these trucks is 10 miles per hour empty and 8 miles per hour loaded. G.R.S.

Riderless cars operate on alternating current. R. F. EMERSON. *Elec. World*, **97** [9], 404–405 (1931).—The transfer car system combines the operating economies of alternating current, the reliability, sturdiness, and simplicity of the squirrel-cage motor, the safety and reduced man power that goes with centralized operating control, and the further economies of regenerative operation. G.R.S.

Heavy-duty manometers. ANON. *Chem. Met. Eng.*, **38** [2], 107 (1931).—The "Hi-Presssure" type manometer is suitable for working pressures up to about 400 lb. per sq. in. Slightly modified, it is available for pressures up to 2500 lb. The second manometer of Series D is built entirely of steel. It is intended for use with pressures up to 2000 lb. G.R.S.

Air conditioning in refractory plant drier. ANON. *Brick Clay Rec.*, **78** [4], 209 (1931).—A description of an air-conditioning drier at the Bessemer Brick Co. is given in detail. Illustrated. E.J.V.

Air thermostat for corrosive research. U. R. EVANS. *Chem. & Ind.*, **50** [4], 66–67 (1931).—The general plan is shown diagrammatically of a cupboard whose walls are maintained at a desired temperature, thus insuring samples placed in the cupboard attaining the same temperature. The inner walls are metal and the outer are of an insulating material. The construction is described in detail. G.R.S.

Work-cycle timer. ANON. *Chem. Met. Eng.*, **38** [2], 106 (1931).—Starting, stopping, heating, cooling, etc., may be controlled by means of a new programming controller. G.R.S.

Removal of dust from generator gas. ANON. *Keram. Rund.*, **38**, 188–90 (1930).—Centrifugal and baffle purifiers, filters with various filtering media, and electrical precipitators to remove dust from generator gases are described. H.I.

Atmospheric exposure and laboratory tests on nonferrous screen cloth. G. WILLARD QUICK. *Proc. A.S.T.M.*, **30** [I], 864–80 (1930).—This report presented through Committee D14 on "screen wire cloth" gives the results of exposure tests on nonferrous screen wire cloth which has been in position for over 4 yr. Coincidental with the exposure tests there have also been obtained analyses of the atmosphere for SO_3 content, the results of which are given. Since the exposure tests are now commencing to show failures, it is anticipated that the results will become of increasing importance and interest as time goes on. R.A.H.

A laboratory method for grading abrasives. JOHN W. VANDERWILT. *Econ. Geol.*, **24**, 853–59 (1929).—A series of connected siphons is used to grade abrasives as fine as 0.001 mm. Convection currents are avoided by keeping the classifier at constant temperature. (*C.A.*)

Aging mixer. ANON. *Tonind.-Ztg.*, **55** [6], 87–88 (1931).—A new mixing machine is described in which the raw materials age for a certain time after having been thoroughly mixed. It works in combination with an edge mill and is installed between it and the molding machines. M.V.K.

Improvement in slurry mixer and stirrer. A. VOGT. *Zement*, **19** [34], 809–10 (1930); *Rock Prod.*, **34** [4], 84 (1931).—V. states that the cost of mixing and stirring

cement slurry is an important item. He describes, with illustration, a compressed-air mixer of simple requirements and exceptionally low operating costs. The tank is used for constant stirring and for admixing dry material to the slurry in it. Stirring is accomplished by means of circulation caused by a lowering of the specific gravity of the slurry where the compressed air enters the tank. There is a unique arrangement for adding the dry material. W.W.M.

Variable-speed slip pump. ANON. *Chem. Met. Eng.*, **38** [2], 107 (1931).—For pumping ceramic slips and slurries of various sorts, the Patterson Foundry & Machine Co. has developed a position displacement pump which has been further improved by the addition of a variable-speed transmission and a pressure-control mechanism. The discharge may be obtained under practically constant pressure with a minimum of fluctuation. The result is said to decrease wear and tear on all pump parts, produce better filter cake, and provide operation which is partially or completely automatic in character. G.R.S.

Unit pulverizer. ANON. *Mech. World*, **89** [2299], 78–79 (1931).—For general industrial work such as metallurgical furnaces, cement kilns, etc., the "unit" type of pulverizer has many advantages for pulverized fuel firing. The installation and use of the unit pulverizer in a number of English power stations is described in detail. E.P.R.

Pulverizing machinery protection. C. H. S. TUPHOLME. *Elec. Rev.*, **108** [2772], 58–59 (1931).—With the extensive use of pulverized fuel, a need has arisen for protection of the delicate crushing machinery against tramp iron. This magnetic material can be eliminated by means of a magnetic-pulley separator placed ahead of the crusher in the conveyer system. A number of different magnetic-pulley separators are described. E.P.R.

Smoke recorder. LEEDS & NORTHRUP CO. *Brick Clay Rec.*, **78** [4], 222 (1931); *Nat. Glass Budget*, **46** [43], 11 (1931).—A smoke recorder which permits a fireman to tell the density of smoke issuing from the stack consists of a measuring chamber, a recorder of the standard Leeds & Northrup potentiometer type, and a boiler room indicator consisting of five lamps. The color of the lamp burning instantly tells the fireman the smoke condition in the stack. Details of construction and operation are given. E.J.V.

Pyrometry in porcelain enameling. I. ANON. *Better Enameling*, **2** [2], 18–23 (1931).—A statement of the basic principle of the thermoelectric pyrometer, a description of base metal and noble metal thermocouples, and the operation of indicators and recorders are given, together with diagrams showing typical pyrometer installations. W.C.O.W.

Resistance of chromium-plated plug gages to wear. HARRY K. HERSCHMAN. Bur. Stand., *Jour. Research*, **6** [2], 295–304 (1931).—An investigation of chromium-plated plug gages with particular reference to resistance to wear was made. Chromium was deposited on hardened 1.0% carbon steel under varying conditions so as to produce what are commonly referred to as "bright," "milky," and "frosty" deposits. The bright deposits were tested in both the lapped and unlapped conditions. The other two types were tested in the lapped conditions only. The scratch hardness values of chromium plate produced under varying conditions were studied with a view toward seeking an explanation for the cause of differences in the rate of wear exhibited by the various types of deposits. R.A.H.

Optical coincidence gage. I. C. GARDNER AND F. A. CASE. Bur. Stand., *Jour. Research*, **6** [2], 229–37 (1931).—A new type of optical instrument is described which enables one to make measurements in a direction normal to the surface viewed. Furthermore, the method of operation is sufficiently simple to permit its use for routine industrial measurements. The instrument is similar to a military range finder except

that the two telescopes forming the optical system of the range finder are replaced by two microscopes. The magnification of the instrument is approximately 85 and under favorable conditions the probable error of a single reading is approximately ± 0.001 mm. As the settings are made without mechanical contact the instrument is particularly well adapted for measurements where all danger of deformation of the object should be avoided. R.A.H.

Oxygen bomb calorimeter. EDGAR STANSFIELD AND JOHN W. SUTHERLAND. *Can. Jour. Research*, **3** [5], 464 (1930).—The paper describes a stainless-steel Scholes bomb and the modification found necessary to reduce the time for temperature equilibrium, a new calorimeter equipment, and a simplified method for correcting Beckmann thermometer readings. Notes on a vacuum cup calorimeter are also included. W.L.

Properties and applications of the selenium cell. G. P. BARNARD. *Mech. World*, **89** [2296], 17–18 (1931).—The body of the text is divided into two parts, dealing respectively with the properties of selenium and selenium cells and with the practical applications of such cells. A brief historical introduction gives an account of the discovery of the element and of its light sensitive properties. This is followed by a description of the constructional details of various standard types of Class A and Class B selenium cells, the incidence of light upon which produces a change in their electrical resistance. Part II is devoted to the many technical applications of the selenium cell. E.P.R.

Researches on heat-insulating substances. LUDWIK WASILEWSKI AND MACIEJ MACZNYNSKI. *Gas Age-Rec.*, **67** [8], 278 (1931); reprinted from *Prz. Chem.*, **14**, 73–83 (1930).—The Poengsen apparatus was modified in design to insure more accurate results. A simple apparatus is described for making rapid rough measurements of the heat conductivity of various materials. E.J.V.

Machine classifies colors. ANON. *Sci. Amer.*, **144** [1], 52 (1931); *Rock Prod.*, **34** [5], 105 (1931); for abstract see *Ceram. Abs.*, **10** [2], 91 (1931). G.R.S.

Feeders. ANON. *Brick Clay Rec.*, **78** [4], 203–204 (1931).—For feeding coarse, lumpy clay, the reciprocating clay feeder is commonly employed. When clay is fed to a screen, a screw conveyer type of feeder is used. The disk feeder is used in feeding pug mills. A feeder of the multiple type accurately blends materials. The double shaft ribbon feeder is used to feed clay in a constant stream. For automatic feeding of shale to a hammer mill an ingenious type of feeder feeds and regulates the weight of the material fed. Other types are mentioned and all are described. Illustrated. E.J.V.

Effect of particle size on flotation. A. M. GAUDIN, J. O. GROH, AND H. B. HENDERSON. *Mining & Met.*, **12** [291], 17 (1931).—A study of the effect of particle size on flotation was made by two methods: (1) grinding, floating, sizing, and analyzing mineral mixtures and (2) sizing and analyzing the products of several mills. Sizing was done by elutriation in water and acetone to as fine as 2200-mesh (about 5 microns). Broadly speaking, the following conclusions were reached: (1) results obtained by the two methods of study are in agreement; (2) the usual notion about the relative ease of flotation of fine particles does not agree with the facts; (3) there is a time sequence of flotation with regard to particle size, the medium-coarse particles floating first; (4) no successful method of floating extremely fine pulps has been found; (5) recovery is optimum in a certain well-defined size range; (6) selection is optimum in another well-defined size range. Several hypotheses are discussed to account for the nonrecovery of fine, otherwise floatable particles. E.J.V.

Service tests on rubber belts. E. G. KIMMICH. *Proc. A.S.T.M.*, **30** [II], 957–64 (1930).—K. gives results of tests on rubber belting to determine the influence of various service conditions on resistance to ply separation. Various combinations of pulley diameters, tensions, belt speeds, and thicknesses were used. R.A.H.

Resistance of metals suitable for dies to the abrasive action of plastic clay. ANON.

Bur. Stand., *Tech. News Bull.*, No. 166, pp. 17–18 (1931).—In this investigation it has been found that when the extrusion pressure increases, the abrasion loss of the specimen dies also increases. The data obtained from nearly 200 tests have been analyzed and the equation determined which represents the relation between extrusion pressure and abrasion loss. The equation expressed numerically is $y^n = x/c$, in which y = the abrasion loss and x = the extrusion pressure; n and c are constants for materials having the same "wear values," but differ for materials of different "wear values." For metals and alloys of increasing resistance to abrasion the value of n diminishes and c increases, and the opposite is true for those of less resistance to abrasion. R.A.H.

Wire rope. A. LESCHEN & SONS ROPE CO. *Clay-Worker*, **95** [2], 122 (1931).—A list of "don'ts" for safety and service in the use of wire rope is given. E.J.V.

Anti-frictionizing a cement plant. A. K. WEST. *Rock Prod.*, **34** [1], 15–52 (1931); for abstract see *Ceram. Abs.*, **10** [4], 284 (1931). W.W.M.

Economy of anti-friction bearings for motors and generators. L. F. MILLER. *Rock Prod.*, **34** [1], 145–49 (1931).—M. covers, from an operating viewpoint, the subject of ball- and roller-bearing electric motors from preliminary inspection, assembly, care, and lubrication to the actual dollars and cents saving from their use. Illustrated. W.W.M.

Measuring, testing, and control apparatus at the Leipzig Fair, 1930. L. LITINSKY. *Messtechnik*, **6** [6], 155–64; [7], 186–94; [8] 209–17 (1930).—A detailed description of the many different types and makes of measuring, recording, physical testing, and control equipment on display at this famous Fair is given. Many of the items are illustrated. E.J.V.

BOOKS, CATALOGUE, AND PAMPHLET

Electrical Equipment. T. C. LLOYD. John Wiley & Sons, New York. 287 pp., illustrated, diagrams, tables. Price $3.50. Reviewed in *Mining & Met.*, **12** [291], 18 (1931).—This book is intended for students of engineering who have studied the theory of the motor, generator, and transformer, and wish a brief account of the theory of a wider variety of electrical equipment as a guide to the selection of apparatus for given requirements. In addition to the fundamental machines, L. discusses switchboards, meters, storage batteries, illumination, heating transmission, distribution, and rectification. Comparative cost data are given, and economic questions discussed. E.J.V.

Electroplating: A Survey of Modern Practice. SAMUEL FIELD AND A. DUDLEY WEILL. Isaac Pitman & Sons, 1930. 205 pp., illustrated, tables. Price $2.00. Reviewed in *Mining & Met.*, **12** [291], 18 (1931).—This is a concise treatise which brings together the results of modern research for the practical electroplater. E.J.V.

Investigation and Calculations on Air-Conditioning Plants. (Luftbefeuchtungsanlagen Untersuchungen und Berechnungen). FRITZ KASTNER. R. Oldenburg, Munich and Berlin. 84 pp., illustrated. 6.50 Rm. Reviewed in *Mining & Met.*, **12** [291], 18 (1931).—This is a report on an investigation undertaken to determine accurate data as a basis for the design of air-conditioning plants. Conditions of air flow and humidity were determined by measurement and compared with theoretical conclusions. Various methods of conditioning were compared. Directions to designers are given. E.J.V.

Filtration and Filters. J. A. PICKARD. *Jour. West. Soc. Eng.*, **36** [1], 61 (1931); for abstract see *Ceram. Abs.*, **9** [4], 298 (1930). W.W.M.

Marshall Cold-Start Oil Engines. ANON. *Refrac. Jour.*, **6** [65], 170 (1931).—Catalogue No. 2094/2 BR. The Marshall Cold-Start Heavy Oil Engine is one of the most recent developments of the Diesel engine which first appeared about 1893. The notable characteristics of engines of this class are their extremely high fuel economy and their

ability to work on heavy fuels of the petroleum series, as well as on tar oils and certain residuals. It also possesses the obvious advantages derived from the absence of an ignition system. Illustrated. E.P.R.

Ohio crusher. ANON. *Pit & Quarry*, **21** [10], 92 (1931).—The James H. Beans Foundry Co. has issued a 4-page pamphlet describing and illustrating a new type of crusher which has met with amazing success. Features are simplicity of construction, ruggedness, and unusually high capacity. E.P.R.

PATENTS

Making colored granules and the article made thereby. RALPH L. ATKINSON. U. S. 1,792,058, Feb. 10, 1931. Method of making colored granules comprising the steps of reducing compacted raw clay or shale to grains of the ultimately required size or sizes, separating it from finer sizes and dust, and heating to a hardening temperature without fusion.

Tile-glazing machine. GEORGE F. WILDE AND BENNET K. ESKESEN. U. S. 1,792,788, Feb. 17, 1931.

Drying clayware, etc. FRANK M. HARTFORD. U. S. 1,793,086, Feb. 17, 1931.

Screen for ball mills. HARRY S. LEE AND WEBSTER LEROY KAISER. U. S. 1,793,495, Feb. 24, 1931.

Continuous method of chromium plating metallic wires or strips. BYRON V. MCBRIDE. U. S. 1,794,973, March 3, 1931.

Kilns, Furnaces, Fuels, and Combustion

Continuous kiln with electric heating. ULRICH ASCHMANN. *Keram. Rund.*, **38**, 171–72 (1930).—A continuous tunnel kiln designed by Siemens-Schuckert for decorating porcelain at temperatures from 800 to 900°C with electric heat is described. The kiln is in operation in Sweden where electric power is cheap and combustibles are scarce. It consists of two parallel tunnels. Conveyer baskets carried on rollers attached to the kiln floor are pushed into one end of a tunnel by hand-operated winches, through the preheating zone into the firing zone where they are transferred by a lateral pusher into the parallel tunnel and returned in the opposite direction through the cooling zone. The tunnels are separated in the firing zone by a partition but the preheating and cooling zones are continuous, thus providing the easiest means of transferring heat from the cooling ware to the unfired ware. Heating elements are spirals of a special chrome-nickel wire wound upon refractory supports in the sides and roof of the tunnel and radiate directly upon the ware. The elements are divided into several groups, each group being controlled separately. Current consumption is not more than 28 kilowatt hours for every 100 kg. gross weight (including car, etc.) or not more than 82 kilowatt hours for every 100 kg. of finished ware. H.I.

Micro-furnace for temperatures above 1000°. H. S. ROBERTS AND G. W. MOREY. *Rev. Sci. Instruments*, **1**, 576–79 (1930).—The furnace is a strip of platinum-rhodium foil (Pt 60% Rh 40%) 0.01 mm. thick and 8 mm. wide, formed into a "U" about 10 mm. deep. A second strip of foil may be folded about the first with a small air space between to give better temperature distribution. The strip is connected to large copper sheet leads. Wiring details are given. Temperatures are measured with an optical pyrometer. The charge of fine powder is placed in the U and examined microscopically after heating to determine melting temperatures, phases present, etc. The furnace with the foil described may be used up to 1850°C. Advantages of the furnace are simplicity, cheapness, and rapid heating and cooling. H.I.

Electrical nickel furnace for metallurgical investigations. H. V. STEINWEHR AND A. SCHULZE. *Z. Instr.*, **50**, 194–97 (1930).—A modification of the Holborn nickel fur-

nace consists of a heavy nickel cylinder on which are wound heating elements of chrome nickel and which is surrounded with thin insulation. In the modified furnace, cylindrical holes are bored from top to bottom in the nickel cylinder parallel to the axis and these tubes are connected to an exhaust pump so that temperatures in the furnace may be lowered more rapidly. H.I.

Firing annular kilns. K. O. SCHULZ. *Tonind.-Ztg.*, **55** [10], 143–44 (1931).—S. discusses errors occurring during firing in annular kilns and their influence on the ware. M.V.K.

Formation of fissures in annular kilns. SLOBODIANIK. *Tonind.-Ztg.*, **55** [5], 63–65 (1931).—S. discusses the reasons for the appearance of fissures on the outside walls of annular kilns and concludes that the way in which the cold outside wall is separated from the inside wall which expands is very important; also that the joints between the two walls must be sufficiently large. Kilns having a quadrangular outline are less apt to have fissures than kilns with a semicircular firing channel. M.V.K.

Work and operation of the technical service during 1930. V. BODIN. *Céramique*, **34** [515], 21–24 (1931).—The director of the technical service of the French Society of Ceramic Manufacturers outlines the work of the technical service during 1930. Forty-eight continuous kilns, 8 periodic kilns, 17 driers, and one gas producer were examined in 1930. Considerable success was achieved in reducing the fuel consumption of periodic kilns and at the same time increasing sagger life and improving the product. The work on driers is illustrated by a comparison of two driers. Although similar in design and drying similar products, one drier required 12 days and the other only 3 days for drying the ware. This was shown to be due to the fact that the rate of loss of water was different in different portions of the slow drier whereas drying was uniformly rapid in the fast drier. The courses of study, exposition, official laboratory, and financial situation of the service are reviewed. A.E.R.W.

Heat efficiency in ceramic kilns. OTTO TH. KORITNIG. *Sprechsaal*, **64** [4], 63–65 (1931).—Up to 30% of the heat produced can be lost through the walls, crown, or floor of the kiln. This loss depends on the length of firing time, temperature, and composition of walls, and can be considerably reduced by isolating the walls. Besides the loss of waste gases, K. discusses the loss in unburned fuel and the influence of cracks and joints in the walls of the firing kilns through which cold air enters. M.V.K.

New draft-muffle installation. HANS MÜLLER. *Sprechsaal*, **64** [6], 114–15 (1931).—M. describes a new draft-muffle installation of the system Söllner for firing glass and porcelain ware. M.V.K.

Importance and function of chimneys. ANON. *Lerindustrien*, **34** [2], 7–10 (1931); *Tonind.-Ztg.*, **55** [12], 180 (1931).—The importance and function of chimneys in annular and periodic kilns are discussed and practical suggestions and calculations given. M.V.K.

Mortar for kiln repairing. H. BÜSCHER. *Tonind.-Ztg.*, **55** [7], 99–100 (1931). M.V.K.

New trends in furnace design as applied to combustion chamber volume. H. KREISINGER. *Gas Age-Rec.*, **67** [8], 272 (1931); reprinted from *Proc. Eng. Soc.* [W. Pa.], **45**, 426–40 (1929).—The rate of heat liberation in B.t.u. per cu. ft. of combustion space per hour for normal range of operation is given for various fuels: blast furnace gas, 7000 to 15,000; natural gas and fuel oil, 10,000 to 30,000; pulverized coal (low fusion ash), 6000 to 14,000. E.J.V.

Circular tunnel kiln at Cronin China Company and an automatic decal machine. ANON. *Ceram. Ind.*, **16** [3], 257–58 (1931).—A new circular tunnel kiln and automatic decal machine at the plant of the Cronin China Company are described and illustrated. Data on their operation are also included. W.W.M.

High-vacuum laboratory furnace. ANON. *Messtechnik*, **6** [10], 280–91 (1930).—A description of the molybdenum-wound high vacuum furnace built by the Elektro-Schaltwerk A.-G., Göttingen, is given. Using a receptacle with a volume of 28 cubic decimeters a vacuum of 40×10^{-4} mm. of mercury was obtained in 5 min. and 1.37 kg. of copper was melted in 41 min. with a power consumption of 1.9 kw. hr. Illustrated. E.J.V.

Stokers and furnaces for New England fuels. R. A. FORESMAN AND DONALD J. MOSSHART. *Trans. A.S.M.E.*, **53** [1], 1–8 (1931).—In this paper the authors describe and analyze some of the troubles encountered in stoker installations and discuss the principal factors to be considered in making a successful stoker installation. Among the points discussed are selection of type and size of stoker, preheated air, furnace volume, furnace walls, ash-disposal apparatus, waste fuel, operating methods, banking, boiler operation, and recent stoker installations. Many of the points discussed receive recognition in the majority of plants, but relatively few plants recognize them all. The authors bring these practical matters together in one group. E.P.R.

New instrument measures and controls heating effects of gases. A. E. KROGH. *Ceram. Ind.*, **16** [3], 294–95 (1931).—The Brown Instrument Co. has developed a flame analyzer which can be supplied to measure, record, and automatically control the heating effect of any gas. W.W.M.

Recovery of fly ash from pulverized-fuel stacks by use of stack sprays. J. W. MACKENZIE. *Trans. A.S.M.E.*, **53** [1], 51–54 (1931).—One of the first central stations designed for the unit system of pulverized-fuel operation with preheated air encountered difficulty due to fly ash from the stack. The extent of the trouble was determined by locating boards freshly painted with white paint throughout the district. A water spray installed in the stack stopped all complaints but necessitated lining the stack with acid-resisting material. Tests show that with the spray in operation about 5% of the coal is discharged as solids from the stack and that the spray takes out about 35% of the solids coming to the stack. A detailed description is included of the equipment and methods used for collecting representative samples of the solids in the flue gases. This paper outlines the influences which led the Consumers Power Co. to adopt a spray system in the stacks of its pulverized-fuel fire plants as a means of combating the fly-ash problem, and shows the results which operation and tests have revealed as to the effectiveness of the system. E.P.R.

Flow of gas through a porous body. H. CASSAN. *Céramique*, **34** [514], 5–6 (1931).—It seems probable that Graham's Law could be generalized to include various temperatures by introducing the density as a function of the temperature. Experiments, however, do not verify this. C. points out that in the three modes of gas flow, *viz.*, (*a*) through an orifice, (*b*) by diffusion, and (*c*) by transpiration (through a capillary), the density enters as the square root into (*a*) and (*b*) and as the first degree into (*c*). With a tight sagger, (*a*) does not occur, (*b*) occurs at low temperatures, but (*c*) predominates at high temperatures. In the case of (*c*), viscosity is an important factor. The viscosity of a gas increases approximately as $T^{1.5}$, where T is the absolute temperature. This must be taken into account in experiments at high temperatures. More comprehensive experiments are needed. A.E.R.W.

Mechanical feeding. F. NIEBLING. *Tonind.-Ztg.*, **55** [8], 112–13 (1931).—The advantages obtained are chiefly the greater economy of fuel by uniform charging. M.V.K.

Report of the Fuel Research Board for the year ended March 31, 1929. C. H. LANDER. *Dept. Sci. Ind. Research*, 1929; *Mech. World*, **89** [2299], 74 (1931).—The report of the Director of Fuel Research deals with (1) physical and chemical survey of national coal resources giving the principal characteristics of various coal seams and

methods of cleaning, grading, and blending the coal. (2) Various methods of examination of coal are discussed. These include analysis, microscopic and X-ray examination, assay of coal for carbonization purposes, coking quality of coal, fusion point of coal ash, and methods of sampling coal. (3) The studies of high-temperature carbonization and gasification include the effect of size of coal, horizontal and vertical gas retorts, and the production and purification of water gas. (4) Low-temperature carbonization is discussed. (5) Studies on coke include methods of testing "reactivity" of coke and the effect of oxidization on the coking properties of coal. (6) Hydrogenation of coal and the production of hydrogen are discussed. (7) Miscellaneous investigations reported include flow calorimeters for liquid fuels, slag-wool for heat-insulating purposes, constitution of coal, primary decomposition of coal, propagation of a zone of combustion in powdered coal, spontaneous combustion of coal, steam raising, heat transfer, and atmospheric pollution. W.L.

Comparative performance of a pulverized coal-fired boiler using bin system and unit system firing. A. E. GRUNERT. *Trans. A.S.M.E.*, **53** [1], 35–50 (1931).—An experimental program has for its object the comparative performance of a modern boiler unit, served first with the bin system of pulverized-coal firing and later, with the unit system of firing, thus making possible comparisons on a common basis. The paper deals with specific types of equipment, certain types of coal, and operating conditions, influenced somewhat by local conditions. The operation of these two systems is compared in three ways: first, on an evaporative-test basis; second, on a basis of actual overall performance; and third, on an operating-cost basis. A record of the pertinent experiences with both systems is given. Owing to the specific nature of the program, no general conclusions are given and there is no intention to contribute to the controversial phase of the matter. E.P.R.

Heating porcelain kilns with coal gas. FRANZ DIETRICH *Gas Wasserfach*, **73**, 1066–74, 1090–96 (1930). (*C.A.*)

Coal as a raw material. E. F. ARMSTRONG. *Chem. & Ind.*, **50** [3], 40–42 (1931).—After giving briefly the nature and origin of coal, A. discusses methods of enhancing the value of coal. Besides burning, it can be carbonized to make gas, treated in coke ovens to make coke, carbonized at low temperatures to make fuel and oil, and hydrogenated. G.R.S.

Action of coal while in process of carbonization. SADAO IKI. *Gas Age-Rec.*, **67** [10], 358 (1931).—Coal is subject to a number of complex physico-chemical changes during carbonization, the quality of coke obtained differing according to the grade of coal used and method of treating. Anthracite, bituminous, and brown coals of different caking powers and pulverized below 100-mesh were used in the tests. They were heated for 15 minutes at temperatures between 100 and 1000°, the coke thereby obtained being ground to the same fineness. The results were compared to those obtained from American pine charcoal, treated at different temperatures. E.J.V.

Recent developments in coal cleaning. R. LESSING. *Chem. & Ind.*, **50** [5], 84–87 (1931).—Neither washing nor pneumatic cleaning are sufficient to remove the mineral or ash-forming materials. A description is given of the "float-and-sink" method using solutions of calcium chloride. Clean coal and its uses are discussed. See also *Ceram. Abs.*, **10** [3], 217 (1931). G.R.S.

Dry coal cleaning. I. F. PROCKAT. *Z. Ver. deut. Ing.; Queensland Mining Jour.*, **31** [12], 511 (1930).—The arrangement of screens in the Bamag-Meguin pneumatic cleaner and the Humboldt dry cleaner are briefly discussed. E.P.R.

Sampling and analysis of coal for export. ANON. *Chem. & Ind.*, **50** [3], 42–43 (1931); *Mech. World*, **89** [2301], 133 (1931).—A brief account is given of the report of the British Engineering Standards Assn. on sampling coal for export. G.R.S.

Fuel or flue-gas treatment. E. W. L. NICOL. *Daily Telegraph; Elec. Rev.*, **108** [2778], 337 (1931).—The problem of eliminating excess sulphur dioxide from power-station flue gases has been tackled by the Fuel Research Board. Success is claimed for large-scale experiments which have been made and it is hoped that in actual practice the heavy cost of "scrubbers" or flue-gas washing plant, will be justified by the results obtained. The sandwich system of fuel blending was designed and used primarily as a means of utilizing coke breeze, in conjunction with bituminous coal, with mechanical stokers of the traveling chain-grate type. The principle of blending coal and coke has more recently been applied with equal success to mechanical stokers of the retort or underfeed type. Admixtures of nonvolatile coke or low-volatile coal, usually considered unsuitable for mechanical stoking, tend to prevent the formation of smoke by reducing the volatile content of the combined fuel as fired. Thus a 50% admixture of coke breeze to bituminous coal containing the average 28% volatile combustible matter would give a total of only 14 to 16% volatile, approximately the same proportion contained in Welsh smokeless coal. E.P.R.

Comparison of the combustion of natural gas and coal. P. MCDONALD BIDDISON. *Gas Age-Rec.*, **67** [6], 189–94 (1931).—After a review of the work done on this subject by previous investigators, B. gives a detailed report of the values obtained in making the various calculations necessary for the comparison. Most of the calculations are given in detail. E.J.V.

Natural gas and brickmaking. ANON. *Gas Age-Rec.*, **67** [9], 303–304 (1931).—The amount of natural gas equivalent to the fuel now used in manufacturing the varied line of clay products is estimated and a geographical division of the required volume of gas that would be required to replace other fuels is given. The disadvantages of other fuels and the advantages of the use of natural gas are listed and discussed. Applications of gas firing to the various different processes encountered in clay products manufacture are cited. Illustrated. E.J.V.

Natural gas as a fuel in the ceramic industry. P. MCDONALD BIDDISON. *Gas Age-Rec.*, **67** [10], 335–38 (1931).—This paper was presented before the Clayworkers Conference, Univ. of Alabama, Feb., 1931. Natural gas is now available in the ceramic centers of Mississippi, Alabama, and Georgia in quantities sufficient to fill all clayworking requirements. Its cleanliness in handling, its flexibility and ease of control and regulation, and its freedom from deleterious ingredients make it an ideal fuel for such processes, while the labor savings and increased firing efficiency attendant upon its use and the increases in plant capacity produced thereby give it a fuel value higher than the comparative cost of other fuels for the same heat content. E.J.V.

Luminous flame burner. T. E. WOODS. *Gas Age-Rec.*, **67** [10], 351–52 (1931).—As a result of experiments with diffusion flame combustion it has been proved that at the higher temperatures, the radiation power of a diffusion on a luminous flame is about five or six times as great as a nonluminous flame of the same temperature. A luminous flame is essentially a low-temperature flame because it radiates its heat as rapidly as combustion takes place. As the heat transfer by radiation is in proportion to the difference between the fourth power of the absolute temperature of the radiating and receiving bodies, it is desirable to have a flame temperature as high as possible when using a luminous flame, and on this account the most efficient possible checker or regenerators should be used. Among the various applications for the luminous flame are glass furnaces, open-hearth furnaces, etc. These are discussed separately. E.J.V.

Long-distance gas (Fern-gas) in Germany. ANON. *Times Eng. Supp.*, **27**, 297 (1930).—Large gas works have been erected at Rothernsee, Magdeburg, to supply central Germany with gas for heating and lighting. H.H.S.

BOOK AND BULLETINS

Publications on Coal Dust; A Compilation of Pertinent Publications. (Das Schrifttum über Kohlenstaub; eine Zusammenstellung der einschlägigen Veröffentlichungen.) O. KNABER. V.D.I. G.m.b.H., Berlin. Price 6 Rm. Reviewed in *Colliery Guard.*, **142** [3656], 329 (1931).—This valuable record of publications dealing with the subject of pulverized coal has been compiled for the German State Coal Council (Reichskohlenrat) in collaboration with a number of important interested bodies, including the coal syndicates. The subdivided references are concise and explicit. E.J.V.

Influence of the Size of Coal during Gas Manufacture. ANON. Dept. Sci. Ind. Research, Fuel Research, *Tech. Paper*, No. 26, 55 pp. (1930). H. M. Stationery Office, London; reviewed in *Chem. & Ind.*, **50** [4], 73 (1931). G.R.S.

Technical Data on Fuel. H. M. SPIERS. Reviewed in *Chem. & Ind.*, **50** [6], 114 (1931); see also *Ceram. Abs.*, **10** [2], 157 (1931). G.R.S.

Tunnel kilns for the ceramic industry. ANON. *Refrac. Jour.*, **6** [64], 142 (1931).—Messrs. Gibbons Bros., Ltd., Dibdale Works, Dudley, Worcs., recently issued a comprehensive brochure dealing with tunnel kilns for the ceramic industry. Details, fully illustrated, are given in the catalogue of the Dressler Tunnel Kiln, and of the Moore-Campbell Electric Tunnel Kiln. E.P.R.

Fuel-fired furnaces. ANON. *Metal Prog.*, **18** [6], 156 (1930).—Bulletin No. B-18 of the Electric Furnace Co. illustrates oil- and gas-fired continuous and batch-type billet heating, forging, and car-type furnaces for heating, normalizing, and heat treating; also labor-saving material handling equipment. E.P.R.

PATENTS

Driving means for mechanical stoker for ceramic annular kilns. JOSEF HANNAK. Austrian 119,630, May 15, 1930. (*C.A.*)

Furnace for ceramic products. WILHELM ECKARDT & ERNST HOTOP G.M.B.H. Fr. 686,488, Dec. 12, 1929. (*C.A.*)

Ceramic kilns. C. H. WECK, KOMM.-GES. Ger. 505,503, Jan. 13, 1929. Details of charging are given. (*C.A.*)

Tunnel kiln for ceramic objects. RENÉ M. D'ARLEUX AND EMILE VIOLETTE. Ger. 505,603, April 21, 1929. Addn. to 439,935. The kiln is heated by a compressed mixture of air and generator gas. (*C.A.*)

Rotary ceramic kiln. FRIED. KRUPP GRUSONWERK A.-G. Ger. 506,710, Jan. 19, 1929. Details are given. (*C.A.*)

Ceramic kiln. PORZELLANFABRIK KAHLA, ZWEIGNIEDERLASSUNG FREIBERG. (Ludwig Wirth, inventor). Ger. 507,880, June 15, 1928. A method is described of heating the kiln directly by the flue gas and by electric heating elements. (*C.A.*)

Tunnel kiln for making fireproof stone, etc. HEINRICH KOPPERS A.-G. Ger. 509,787, March 10, 1929. The kiln has a series of regenerators. (*C.A.*)

Geology

Ferric-oxide hydrates of definite composition. P. A. THIESSEN AND R. KÖPPEN. *Z. anorg. allgem. Chem.*, **189** [1], 113–36 (1930).—The ordinary methods of preparation of the pure oxide hydrates of trivalent iron by hydrolysis or by the alkali precipitation of ferric salts, yielded only one crystalline hydroxide ($Fe_2O_3 \cdot H_2O$) which occurs in nature as the mineral goethite. Dehydration experiments were made on precipitated ferric hydroxide to determine whether breaks on such curves might show the existence of other hydrates; but these dehydration curves were similar to those obtained from other gels

in that they showed a step-like form. These curves are not reproducible and hence the breaks are not due to compound formation but to capillary dehydration. Ferric hydroxide was prepared from ferric ethylate; it hydrolyzes completely at low temperatures and contains no difficultly removable electrolyte. Since it hydrolyzes at low temperatures the oxide hydrates which are formed first of all are not decomposed. The *p-x* and *t-x* curves were made on samples of the hydroxide prepared from ferric ethylate. The method for making the *p-x* curves at high temperatures is described in detail. From the breaks which were obtained on such curves, the existence of the following hydrates was ascertained: $Fe_2O_3 \cdot 4H_2O$, $2Fe_2O_3 \cdot 7H_2O$, $Fe_2O_3 \cdot H_2O$, $Fe_2O_3 \cdot 3H_2O$, $2Fe_2O_3 \cdot 5H_2O$, $Fe_2O_3 \cdot 2H_2O$, $2Fe_2O_3 \cdot 3H_2O$, $2Fe_2O_3 \cdot H_2O$; and there were indications of the existence of two other hydrates $2Fe_2O_3 \cdot 9H_2O$ and $Fe_2O_3 \cdot 5H_2O$. The equilibrium conditions and the methods of preparation of these pure hydroxides are given. The decomposition of the natural minerals goethite and limonite was studied. On decomposition they form an intermediate compound $2Fe_2O_3 \cdot H_2O$. The sample of limonite which was used did not seem to have a composition $2Fe_2O_3 \cdot 3H_2O$ but seemed to be goethite which contained adsorbed water. L.T.B.

Meaning of silicate synthesis for geochemistry. WILHELM EITEL. *Naturwissenschaften*, **18** [47], 1019–25 (1930).—E. points out the contributions of petrology and experimental silicate investigations to the knowledge of the behavior of the lithosphere. From the available material which petrographic studies have given us during the past hundred years, he shows how the modern synthetic studies of the fundamental systems gives us a clue to the principal laws of element migration. L.T.B.

Method for determination of water and carbon dioxide in silicates. E. DITTLER AND H. HUEBER. *Z. anorg. allgem. Chem.*, **195** [1], 41–59 (1931).—The determination of small amounts of water in silicates requires special methods. Often high temperatures must be attained to drive off the last water of constitution; but then other constituents such as F, CO_2, SO_3, etc., may be evolved. Furthermore, the determination of water is affected by the presence of ferrous iron and at high temperatures water may be decomposed by the constituents of the silicates. J. Linder has given a method for the determination of water which has been but little used in silicate analysis. By this method the water is driven off at high temperatures and absorbed in α-naphthyl-oxychlorphosphene, $C_{10}H_7POCl_2$, by which the water is decomposed to form HCl. The acid formed may be titrated with NaOH. The method is only suitable for materials which contain small amounts of water but the accuracy is far greater than by the gravimetric absorption method. L.T.B.

Different properties of silicate rocks. M. L. LONGCHAMBON. *Tonind.-Ztg.*, **53** [100], 1762 (1929); for abstract see *Ceram. Abs.*, **9** [7], 535 (1930). M.V.K.

A study of peraluminates of alkali and alkaline earth metals. J. PRÁŠEK. *Collection Czechoslo. Chem. Comm.*, **2**, 653–64 (1930).—By the addition of H_2O_2 to a solution of the aluminate, the following compounds were obtained: $K_2O \cdot O \cdot Al_2O_3 \cdot 8H_2O$, $K_2O \cdot 2O \cdot Al_2O_3 \cdot 8H_2O$, and the corresponding Na compounds. By mixing a solution of alkaline earth chloride containing H_2O_2 with alkali aluminate, there were precipitated $Li_2O \cdot 2O \cdot 2Al_2O_3 \cdot 28H_2O$, and $Li_2O \cdot 4O \cdot 4Al_2O_3 \cdot 25H_2O$; $MgO \cdot 2O \cdot Al_2O_3 \cdot 10H_2O$, and the corresponding compounds of Ca, Sr, and Ba. By shaking the last named with excess of hydroxide, $4CaO \cdot 2O \cdot Al_2O_3 \cdot 15H_2O$, $3SrO \cdot 2O \cdot Al_2O_3 \cdot 20H_2O$, $3BaO \cdot 2O \cdot Al_2O_3 \cdot 20H_2O$ were obtained. These peraluminates are stable at ordinary temperature, but lose O_2 at 110°; with dilute acids, H_2O_2 is liberated. The alkali compounds, which are soluble, ionize thus: $2K^+ + [Al(OH)_3O_2H]^- + [Al(OH)_4]^-$. (*C.A.*)

Amphoteric oxide hydrates and their water solutions and crystalline compounds. GERHART JANDER AND AUGUST WINKEL. *Z. anorg. allgem. Chem.*, **193** [1], 1–28 (1930). —The authors report a series of studies on the state of aggregation, diffusibility, and

optical absorption of ferric salt solutions on varying the hydrogen-ion concentration. X-ray diffraction patterns showed that only one compound was formed; the pattern corresponded to that of the mineral goethite. Some studies on the aging of iron hydroxide gels are included. L.T.B.

Clays as minerals and as colloids. C. E. MARSHALL. *Pottery Gaz.*, **56** [644], 241 (1931).—American X-ray research on kaolins and other clays is discussed. The colloidal content is discussed with special emphasis on the simplest and most fundamental properties of the particles. A distribution curve based upon Stokes' law is generally used to test particle size with reasonable accuracy down to 1 $\mu\mu$. E.J.V.

Origin and age of clays. E. L. MERTZ. *Lerindustrien*, **33** [25], 135–38 (1930); *Tonind.-Ztg.*, **55** [12], 180 (1931).—The origin and age of clays with special regard to clays from Denmark are discussed. M.V.K.

Crystal growth. W. KOSSEL. *Naturwissenschaften*, **18** [44], 901–10 (1930).—A development of the theory of crystal growth in the light of some of the modern theories of crystal structure is described. L.T.B.

Detection of rock salt by the methods of electrical surveying. T. ALTY AND S. ALTY. *Can. Jour. Research*, **3** [6], 521 (1930).—Experiments on the detection of rock salt deposits by electrical methods are described. It is shown that these methods give definite indications of the depth of the deposits when the latter is as much as 600 ft. below the surface. The interpretation of results obtained by the single electrode probe method is discussed. W.L.

Bauxites and their chemical composition. V. CHARRIN. *Génie Civil*, **96**, 63–64 (1930).—The four principal bauxite deposits of France are Herault, Var, Bouches-du-Rhone, and Ariege, the first two being worked at present. French bauxites are divided into four types: (1) Red bauxite, usually pisolitic, containing 50 to 60% Al_2O_3, 18 to 25% Fe_2O_3 and less than 5% SiO_2 is used for the production of aluminum and aluminium salts and for high-alumina cement. (2) White bauxite contains from 60 to 70% Al_2O_3, 30 to 40% SiO_2, and 2 to 4% Fe_2O_3, is usually granular, and is used in small amounts for production of artificial gems, paper, and sugar. (3) Gray bauxite contains 50 to 60% Al_2O_3, about 10% SiO_2, and about 10% Fe_2O_3. It is frequently pisolitic and is used for abrasives. (4) Refractory bauxite contains 50 to 60% Al_2O_3, 30 to 40% SiO_2, and 2 to 4% Fe_2O_3. H.I.

Bauxites of Ariege. V. CHARRIN. *Génie Civil*, **97**, 281–83 (1930).—The geology and occurrence of a deposit of bauxite situated in the rugged and somewhat inaccessible foothills of the Pyrenees is described. The deposit provides a reserve of large tonnage and of fair quality for the time when the deposits now worked are exhausted. H.I.

Bauxites of Catalonia. V. CHARRIN. *Génie Civil*, **97**, 444–45 (1930).—The geology and theories of origin of a deposit of bauxite near Barcelona are described. Only 100,000 T. of a mediocre grade are available. H.I.

Composition, age, and conditions of deposit of the French bauxites. JACQUES DE LAPPARENT. *Rev. univ. Mines*, **4** [8], 230–36 (1930).—Analyses of certain types of bauxites are included. L.T.B.

Recent developments in the mining and processing of feldspar. ALBERT ACKERMAN. *du Pont Mag.*, Dec., 1930; *Pit & Quarry*, **21** [11], 80–82 (1931).—The feldspars are all anhydrous silicates of aluminium containing either potash, soda, or lime alone, or two of these bases together. In the form commonly known as feldspar rock, it occurs in pegmatite formations of crystalline rock masses with quartz, mica, and other minerals. E.P.R.

Geology and mineral resources of the Alexis quadrangle. H. R. WANLESS. Ill. State Geol. Surv., *Bull.*, No. 57 (1930).—The quadrangle comprises 225 square miles of Mercer and Warren counties. W. gives detailed data on coal, limestone, shale, and sand-

stone, presents structure maps, summarizes geologic history, and discusses the mineral resources. The report includes a map showing economic geology and surficial formations, describes the buried preglacial valleys that may be sources of water supplies, and gives other economic and educational data in regard to the geology of the earth. Workable coal beds are scattered over all except the west side and southwest part of the quadrangle. The coal has a high moisture content, high ash content, and nearly equal parts of volatile matter and fixed carbon. Shale and clay suitable for the manufacture of brick and tile occur in the Pennsylvanian and Pleistocene systems in the quadrangle. The plants of the Hydraulic Press Brick Co., Northwestern Clay Mfg. Co., and Monmouth Clay Mfg. Co. are described. Pre-Illinoian sand is worthy of consideration for special uses such as sandblast sand, filter sand, engine sand, and molding sand.

A.E.R.W.

Garnet deposit. ANON. *Abrasive Ind.*, **12** [3], 31 (1931).—The Pacific Coast Garnet Co., Ltd., has opened extensive garnet deposits in San Bernardino county, Calif. The material occurs in large boulders and is of the andradite variety. Chemical analysis shows a hardness of 7 to 7+ on Moh's scale, while the material is said to be nearly 100% pure garnet. It shows continued sharp cutting edges with each fresh fracture of the crystals. Tests have been conducted to determine the abrasive qualities of the garnet for glass grinding and the results reveal that the new material is fast cutting. It is also planned to give the new garnet a thorough test on other abrasive operations where garnet is used. E.P.R.

Diatomite in Canada. ANON. *Chem. News*, **142** [3690], 9 (1931).—The large increase in the annual consumption of diatomite is mainly due to successful research on its domestic and industrial uses. It is used as an insulator and filter medium. Numerous deposits in Canada, many of high quality, are being investigated. G.R.S.

Kaolinitic clays. A. GRANGER. *Céramique*, **34** [515], 24–25 (1931).—G. points out that the name kaolin is being loosely applied to a number of materials on the basis of a very superficial examination of their properties. He describes several materials having the appearance but not the essential properties of kaolin. True kaolin will have a total of combined water and moisture of about 15% but the so-called kaolin of Volnovakh will have about 32%. Equal weights therefore give different fired weights. G. suggests calling the Volnovakh kaolin a "kaolinitic clay." A.E.R.W.

Unusual stalactites. J. A. BARTRUM. *N. Z. Jour. Sci. Tech.*, **12**, 188–92 (1930).—Stalactites of unusual megascopic structure found in a lava tunnel at Auckland analyzed as follows: moisture 27.42%, loss on ignition 15.36, Al_2O_3 21.89, SiO_2 33.41, undetermined 1.92%; the combined H_2O being far in excess of kaolinite or opal requirement. It is suggested that the stalactites are due to accretion of colloidal SiO_2 and kaolin from overlying soil under conditions favoring local enrichment of soil-water in colloids.

H.H.S.

Titanium in New Zealand soils. H. O. ASKEW. *N. Z. Jour. Sci. Tech.*, **12**, 173–79 (1930).—Ti in N. Z. soils varies from 0.25 to 1.50%. There appears to be correlation between Ti and Fe content, both elements increasing together, but none between Ti and Mn. H.H.S.

Emery mines pass century mark. ANON. *Abrasive Ind.*, **12** [3], 30 (1931).—The abrasive industry in the U.S. is a century old, for 100 yrs. ago emery deposits were first discovered near Chester, Mass., while making a cut for railroad. E.P.R.

BOOKS AND BULLETIN

Moler Brick. Development of a Specialized Danish Industry. (Über Molersteine. Die Entwicklung einer bedeutenden dänischen Spezialindustrie.) H. J. HANNOVER. Danmarks Naturvidenkabelige Samfund, Copenhagen, 1927. Reviewed in *Tonind.-*

Ztg., **55** [14], 204 (1931).—H. treats briefly the origin of the large deposits of diatomaceous earth and the structure of the substance found on the islands of Mors and Fur. The name "Moler" was first used in 1811 by C. Schades in a description of the island Mors. It is composed of two Danish words, "Mo" signifying "diatomaceous earth" and "Ler" meaning "clay," thus explaining simultaneously the property and origin of the substance. Moler was formed by the deposition of the solid particles of slime water on the diatomaceous deposits of the sea bed. Moler is distinguished from other kinds of diatomaceous earth by its clay content. Its physical properties are an exceptionally small specific gravity, capability of absorbing water, sound impermeability, and capacity of insulating heat and cold. Moler products are therefore used for thermal insulation of kilns and cooling installations, for construction of sound-proof walls, for flooring in iron concrete constructions, and roofing. Raw and fired moler mixed with lime and cement are used as mortar. Tests with concrete prepared from Portland cement with additions of moler showed its superiority over that of pure Portland cement. M.V.K.

Physical Chemistry in Its Application to Problems of Mineralogy, Petrography, and Geology. (Die physikalische Chemie in ihrer Anwendung auf Probleme der Mineralogie, Petrographie und Geologie.) R. MARK AND H. JUNG. G. Fischer, Jena, 1930. Price 10 M. *Z. phys. Chem.*, **151***A* [5], 467–68 (1930).—In 1911 when R. Mark published the first edition of this book, the development of mineralogy and petrography from the standpoint of physical chemistry had just begun. The application of the phase rule was still merely a program. Since H. Jung has republished this book under the present title, we should expect to find in it an account of the progress made in applying physical chemical principles to these subjects. It is to be regretted that the author failed to accomplish such a purpose. One gains the impression from this edition that he has made his task too easy, for the changes from the older edition are of inconsequential nature. There are some condensations, rewritings, and a few chapters are extended, but one would expect to find a fuller account of recent investigations in this field.

L.T.B.

Barite and barium products in 1929. R. M. SANTMYERS AND B. H. STODDARD. Bur. Mines, Mineral Resources of the U.S. 10 pp. 5¢. This annual chapter presents data on production, consumption, exports, and imports of this mineral. R.A.H.

Chemistry and Physics

Chemistry of crystals and silicates. F. MACHATSCHKI. *Forschungen Fortschritte*, 418–19 (Nov. 1930); *Giorn. chim. ind. applicata*, **12** [12], 588 (1930).—Silicates often have a molecular structure so complex that they form a group of compounds to themselves. There are other elements, Be, V, As, and probably P, Mo, W, and Cr, which exist in high valence forms and act similarly to Si. It has long been known that some types of silicates can substitute ions of different valence in their crystals, provided the equilibrium of the electronic valence be maintained in the entire complexity of the formula. Examples are the triclinic calcium-sodium feldspars (plagioclases) which form an uninterrupted series terminating in albite ($NaAlSi_3O_8$) and anorthite ($CaAl_2Si_2O_8$). The Na′ of albite can be replaced in various proportions by Ca″ while at the same time Si′′′′ is replaced by Al′′′. M. supposes that from the structural viewpoint the Al of albite already has a function analogous to that of Si and that the Al and Si ions form with the O ions a continuous lattice with a negative charge, whose valences are satisfied with positive cations Ca″, K′, Na′, and Ba″. The lattice would be made up of tetrahedrons whose vertices are occupied by oxygen ions and the center by Si or Al. As every O ion is common to 2 tetrahedrons which coincide through one vertex, the formulas of the

lattice would be $[(Si,Al)_x O_{2x}]$ with a negative valence n. If the lattice contains only Si and not Al, the formula limit SiO_2 is obtained to which cations are not necessary for saturation. The other condition cannot exist because not all the Si can be replaced by Al. This hypothesis was confirmed by X-ray analyses of feldspars. At times the Si is replaced by cations other than Al and O'', *viz.*, OH' and F'. The metasilicates (pyroxene and amphibole) to which belong the formulas $[(Si,Al)_x{\cdot}O_{3x}]$ and $[(Si,Al)_x{\cdot}O_{3x-x/4}]$ show a crystalline lattice similar to that of feldspars. From these experiments M. determined that the so-called "isomorphism of valence" to which the formation of solid solutions is attributed, has in reality little importance in the constitution of the crystalline structure, an importance which is limited in every case to the formation of crystalline compounds wherein the equal valence coincides with a corresponding position in the space inside the crystal. *E.g.*, the monoclinic minerals, clinozoisite, epidote, and orthite, form crystal compounds and parallel growths. The latest formula given, $H^{II}_{R_2}{}^{III}_{R_3}Si_3O_{13}$, corresponds relatively well to clinozoisite and to epidote, where $^{II}_{R}$ is Ca in both, while $^{III}_{R}$ is Al in the first and in the second Al is partly substituted by Fe. In orthite there are often notable quantities of rare trivalent earths and trivalent Mg which cannot be in accordance with the formula above. Moreover, orthite and epidote contain notable per cents of F. It has been found that the large cations of the rare earths cannot replace Al, while the small cation Mg'' cannot replace the large Ca'' cation. M. proposes the formula $X_2Y_3Si_3(O,OH,F)_{13}$ where X represents the cations Ca'', Y''', Ce''', Na', Ce'''', Th''''; Y represents Al'''', Fe''', Fe'', Mg'', Ti''', and Ti'''', and where O'' can be replaced by OH' and by F', providing the sum of the valences be constant. Similarly there can be studied for other types of silicates, simple formulas expressed with few symbols each, corresponding to a series of elements with a valence not necessarily equal, but which can occupy corresponding positions in the crystalline lattice. M.V.K.

Chemical analysis of silicates. P. GRIGORIEV. *Bldg. Materials*, No. 9–10, 6 pp. (1930).—G. discusses different methods used for chemical analyses of silicates in U.S.S.R. and points out their advantages and disadvantages. M.V.K.

Photoelastic dispersion of vitreous silica. L.N.G. FILON AND F. C. HARRIS. *Proc. Roy. Soc.* [London], **130***A* [813], 410–31 (1931).—Dispersion of the double refraction induced by stress was determined on two rectangular blocks of vitreous silica. The stress was applied by means of a lever and weight. In order to eliminate the effect of lack of homogeneity all the light entering the spectroscope slit had passed through a narrowly-limited region of the specimen. The observed (C) and calculated (C') stress-optical coefficients showed remarkable agreement. The differences between these values are plotted against λ. A similar curve was obtained from measurements on another glass with a silica content of 67.5%. Glasses having a lower silica content did not exhibit such a curve. The results were confirmed by an independent method. C was measured throughout the spectrum at definite wave-lengths, with the specimen under constant load. It seems that the effect of stress may be to cause a temporary partial dissociation of the molecules of silica, rendering the free periods of the silicon atoms effective. G.R.S.

Chemistry of silicon. I. F. PONOMAREV. *Ceramics & Glass* [Supp.], **6** [7–8], 34–37 (1930).—P. discusses the chemistry of silicon and its use in glass, ceramics, refractory materials, and cement. M.V.K.

Study of silicate analysis. I. Determining silica, alumina, and ferric oxide. SHIGEYUKI SHINKAI AND AYAO HAMASAKI. *Jour. Jap. Ceram. Assn.*, **37** [436], 113–21 (1929).—A new method of determining silica, alumina, and ferric oxide in silicate is proposed. The cake obtained by fusing silicate with sodium carbonate or fusing mixture is decomposed with HCl. After the addition of a few drops of HNO_3, the solution is evaporated to dryness. A suitable amount of ammonium chloride powder is added and

the mixture is mixed well after the addition of a little water. The solution is made slightly alkaline with ammonia water and is evaporated again to dryness. By the treatment, silica, aluminium hydroxide, and ferric hydroxide are made insoluble in water while calcium and magnesium remain as chlorides. The precipitate is extremely compact and is far more easily filtered, washed, and ignited than that obtained by the usual method. Probable errors calculated from the results of ten analyses of a Roseki by $\pm$ 0.6745 (Σ d²/$n(n-1)$) are SiO_2 77.282 $\pm$ 0.011% and Al_2O_3 + Fe_2O_3 17.550 $\pm$ 0.005%. See also *Ceram. Abs.*, **10** [1], 70 (1931). S.K.

Quick determination of silica with membrane filter. Kozo Fujii. *Jour. Jap. Ceram. Assn.*, **37** [433], 19–24 (1929).—The method of determining silica with the aid of membrane filters is described, and the results obtained at the laboratories of the Asano Cement Co. are discussed. It is concluded that the membrane method gives reliable results and saves time considerably in the determination of silica in Portland cement and also that further investigations are required, however, for samples which need alkali fusion, *e.g.*, soft quartzite used in the manufacture of Portland cement. S.K.

Rapid analytical method for silica brick. R. H. Reich. *Ber. deut. keram. Ges.*, **11** [9], 503 (1930).—R. describes a method which permits the rapid determination of iron and lime in silica brick. This determination takes 2½ hr. The accuracy is sufficient. This method cannot be used for silica raw batches. Mix 5 g. of the ground silica brick with 100 cc. diluted sulphuric acid (1:4), 25 cc. hydrogen peroxide (3%), and 10 cc. hydrofluoric acid (40%) and place in a lead receptacle. Boil for 30 min. uncovered. Dilute to about 300 cc. and filter into a 500 cc. flask. Wash the lead beaker and residue on the filter with cold water. Drops of hydrosulphuric acid are added to the washing water to keep the lead sulphate insoluble. Take 100 cc. for lime determination and 100 cc. for iron. For lime determination, add 200 cc. distilled water and 6 to 8 drops methylene-orange as indicator, neutralize with very dilute ammonia until the color changes and add dilute hydrochloric acid to get rose tints. Then add 10 cc. acetic acid, boil, and precipitate the lime with boiling ammonium oxalate solution. After precipitating, boil again for a few minutes, settle for about 10 min., filter, and wash. I.R.

Perchloric acid for determination of silica in limestones. Carroll B. Core. *Rock Prod.*, **34** [4], 58–59 (1931).—C. discusses the dangers and advantages of using perchloric acid in the determination of silica in limestone and gives a method of procedure for the analysis. Samples containing not more than 16% SiO_2 and 7.5% R_2O_3 are best analyzed if first blasted to a sintered mass. Limestones containing as little as 50% $CaCO_3$ can be made soluble by mixing one-fourth to one-half gram of sodium carbonate with a half-gram sample and heating over a blast lamp. W.W.M.

Determination of the percentage base saturation of soils and its value in different soils at definite p_H values. W. H. Pierre and G. D. Scarseth. *Soil Sci.*, **31** [2], 99–114 (1931).—A study was made of the determination of the percentage base saturation of soils when based on the $Ba(OH)_2$ – NH_4Cl and the $Ba(C_2H_3O_2)_2$ – NH_4Cl methods of determining total exchange capacity. It was found that the $Ba(OH)_2$ – NH_4Cl method gave values for total exchange capacity which averaged 17.9% higher with a group of sandy soils and 12.3% higher with a group of heavier soils than did the $Ba(C_2H_3O_2)_2$ – NH_4Cl method. With the limed soils of the latter group the $Ba(OH)_2$ – NH_4Cl method gave values which averaged only 4.4% higher. A study was made of the percentage base saturation of a number of soils of similar and of different origins at like p_H values. It was found that soils of the same reaction may vary considerably in their percentage base saturation. Highly-weathered soils (Piedmont Plateau) have a lower degree of saturation at given p_H values than less-weathered soils. No relation was found between the organic matter content of soils or the nature of the bases present in

the exchange complex and the percentage base saturation of the soils at like p_H values. The silica-sesquioxide ratio and total exchange capacity of the colloids extracted from the soils showed a general correlation with the percentage base saturation values of the soils at like p_H values. Determinations were made of the avidity of the soil acids in the different soils at similar p_H values. Highly-weathered soils were found to have weaker acids than less-weathered soils. G.R.S.

Interaction between ammonia and soils as a new method of characterizing soil colloids. A. N. PURI. *Soil Sci.*, **31** [2], 93–97 (1931).—Soils react with bases slowly and equilibrium condition can be reached quickly only by adding excess of alkali and removing the excess by leaching or by precipitation as some insoluble salt. A soil made completely unsaturated can combine with an amount of ammonia which may be considered equivalent to its base-exchange capacity. The p_H value of soils containing excess $CaCO_3$, after dilute acid treatment and ammonia saturation, is approximately the same as that of the soil in the natural condition. G.R.S.

Temperature correction in the hydrometer method of mechanical analysis of soils. CHARLES RICHTER. *Soil Sci.*, **31** [2], 85-92 (1931).—Soil suspensions of the same soil at different concentrations but at the same temperature will not give identical results when the temperature correction factor of 0.35 is applied at all concentrations. The same soil suspension which gave a certain reading at 67 °F will not give the same result at a higher or lower temperature if the temperature-correction factor of 0.35 is applied unconditionally. The nature of the curve obtained when hydrometer readings are plotted against the corresponding temperature is shown graphically. A sliding-scale correction table is tentatively suggested, subject to modification. G.R.S.

Indirect determination of lime with sodium oxalate. A. HEISER. *Zement*, **19** [49], 1154–55 (1930); *Rock Prod.*, **34** [4], 84 (1931).—H. has developed a simple and good method for indirect determination of lime, in which he uses the Soerensen sodium oxalate which is more hygroscopic and crystallizes without water of crystallization. H. describes the preparation of the potassium permanganate solution and then gives his procedure in making the analysis. The method is applicable for determination of lime in cement and for examination of limestone, marls, etc. W.W.M.

Determination of fluorine. A. KURTENACKER AND W. JURENKA. *Z. anal. Chem.*, **82** [6–7], 210–17 (1930); *Stahl Eisen*, **51** [5], 148 (1931).—Fluorine is determined by (1) titrating the alkaline fluoride solution with a solution of a metal salt, *e.g.*, aluminium or cerium salt solution which produces a stable complex or an insoluble fluoride; or (2) by decomposing it with boric acid. M.V.K.

Thermal method for rapid CO determination. GERHARD STAMPE. *Messtechnik*, **6** [10], 267–70 (1930).—A method for measuring CO is discussed from its theoretical basis. The mix to be tested for CO is heated over a catalyzer at low temperatures. The CO is then separated from the mixture of gases streaming from the catalyzer as a result of the heating. This process is illustrated by the results of some actual applications. Illustrated. E.J.V.

Methods of determining grain size of dusts and powders. O. M. FABER. *Messtechnik*, **6** [11], 296–98 (1930).—The methods for determining grain size of powders are collated, their advantages and disadvantages being briefly discussed. Microscopic determination rarely suffices. Sieve analysis is not used for all materials and is not practical for grain sizes below 60μ. Of the apparatus for determining finest grain size the Wiegner flaking measurement especially has been preserved. Illustrated. E.J.V.

Physical principle of drying. V. IGINIO. *Corriere Ceram.*, **12** [1], 9–11 (1931).—Drying a ceramic paste consists in eliminating wholly or partly, by evaporation, the hygrometric water and water used for preparation. The factors influencing the rapidity

of evaporation of water have been investigated by Dalton who deduced the following simple formula from the results of his experiments: $M = cS(F - f)\frac{76}{H}$, where M is the mass evaporated in a unit of time, S, the surface of the water to evaporate, F, the maximum tension of the water vapor corresponding to the mean temperature of the air, f, the effective tension of the water vapor in the air, H, the pressure of the atmosphere, and c, coefficient of proportionality. When restricted to the field of ceramics the formula can be simplified by leaving out the factor of pressure, which is kept normal, giving the formula: $M = cS(F - f)$. According to the formula (1) the velocity of evaporation (mass M evaporated in unit of time) is directly proportional to the surface of the evaporating liquid, *i.e.*, the greater the exposed surface area in proportion to the mass, the more rapid is the drying. (2) The same velocity is proportional to the difference between the maximum elastic force F of the vapor, corresponding to the temperature of the liquid, and the effective tension f of the water vapor contained in the surrounding air, which signifies that the temperature in the drying chamber need not be raised but that the air must not be allowed to become saturated with moisture. (3) The coefficient c depends on various elements, especially on the movement of the air. In experiments it has been observed that this increases with the velocity of the air current striking the surface of the drying object. This signifies that drying is more rapid with a greater movement of air in the drying chamber. The following elements are necessary for a rational drying installation: (*a*) surface adequate for the quantity of drying material, (*b*) aspirating tubes to prevent saturation of air, and (*c*) ventilators for circulating air in the chamber. M.V.K.

Drying tile bodies. V. Bodin and P. Gaillard. *Céramique*, **33** [506], 101–105 (1930).—Six tile mixes were investigated. Three were used as semiplastic mixes with plaster molds and three as dust press bodies. Tile 6 x 12 x 24 cm. were made and dried in a test drier with air at 35 °C, air velocity about 0.5 m. per second, and humidity curves ranging from those causing defects to those giving good results. A half-way curve was used in establishing a "limiting curve" and the maximum hourly loss of shrinkage water and pore water was calculated. Finally the following sum was calculated:

$$\frac{\text{Shrinkage water (\%)}}{\text{Maximum hourly loss of shrinkage water (\%)}} + \frac{\text{Pore water (\%)}}{\text{Maximum hourly loss of pore water (\%)}}.$$

The sum was considered to indicate the drying characteristics of the mix in question. The data obtained for the six mixes are given in tabular form. The values vary from about 13 hr. to about 180 hr. A northern clay is quite exceptional which explains the difficulty encountered in drying it in practice. A comparison of the drying periods used in practice and the minimum periods found in the laboratory showed that the drying times used in practice could be reduced in some cases as much as 85%. Lack of control of drying conditions is given for the longer times employed in industry. A.E.R.W.

Delayed crazing of glazes as caused by changes in volume of ceramic bodies. H. H. Holscher. O.S.U., *Eng. Expt. Sta. News*, **2** [8], 3–7 (1931).—Tests to determine the cause of delayed crazing in various bodies were studied. There are several methods which may be used in an experimental investigation of the changes in volume of ceramic bodies caused by moisture penetration: (1) exposure to weather with volume or length measurements, both before and after the weathering; (2) exposure to saturated atmosphere in a closed container in which a free water surface maintains the saturated atmosphere; (3) exposure to steam under pressure in a heated autoclave; and (4) boiling the specimens under water for long lengths of time. Conclusions drawn from the experimental work are as follows: (1) The autoclave treatment causes an increase in the volume of porous ceramic bodies, accompanied by a corresponding increase in weight, the two being roughly proportional. (2) The rate of increase in the volume or weight is rapid

at first and decreases with time, the rate-time curve being apparently parabolic. (3) The expansion from the autoclave treatment is not due to high temperature or pressure except in the presence of water vapor or steam. (4) Cooling under steam pressure as compared to cooling under air pressure causes no difference in length change but causes a marked change in weight. (5) After the autoclave treatment, porous ceramic bodies when dried at 110°C will not return to their original weight or length for long periods of time. Drying at room temperature removes considerably less water than does drying at higher temperatures, indicating that there is probably a definite equilibrium condition for each temperature. Measurements by means of the interferometer have shown, under a rapid heating schedule, that the greatest part of the volume contraction takes place at temperatures varying from 175 up to 350°C. (6) The change in volume is probably not due to the rehydration of the clay molecule within the body. (7) The composition of a body is a more important factor than its absorption in determining its reaction to the autoclave treatment, but for bodies of the same composition, increased absorption is accompanied by increased change in length. (8) Typical American and English ball clays do not expand in the autoclave treatment after having been fired to their maturing temperature. (9) Typical American and English china clays when fired to temperatures below cone 12, and treated in the autoclave show a characteristic volume change. (10) Semivitreous bodies composed of clay, feldspar, and flint show greater length changes than bodies composed of any one clay constituent. (11) All porous ceramic bodies are, in general, subject to the change in volume as caused by the autoclave treatment, and this change will show the same comparative trend as weathering, either outdoors or in a damp jar over water. W.C.O.W.

Producing alumina by acid and electrothermal processes. J. D. EDWARDS AND R. B. MASON. *Chem. Met. Eng.*, **36** [12], 730–33 (1929).—Clay is digested with H_2SO_4 (60%) and the resulting aluminium sulphate purified. Alumina is obtained by decomposing the sulphate, and the gaseous oxides of sulphur are recovered. In the electrothermal or dry process, the impurities in the clay are separated in the metallic state from molten pure alumina. A brief description is given of the nitride process. G.R.S.

Analytical weighing of Al_2O_3. WILHELM BILTZ. *Z. angew. Chem.*, **43** [18], 370 (1930).—B. found that the following precautions are necessary for the quantitative determination of alumina: Samples must be heated to 1000°C or to 1200°C and care must be taken that no water be taken up in the desiccator. By careful determination of the properties of various samples, the change γ-αAl_2O_3 was followed. It was found that γ-Al_2O_3 has a molal volume of 29.8 while that of corundum is 25.7. L.T.B.

Measurement of polarization of the Tyndall beam of aqueous suspensions as an aid in determining particle size. THEODORE HATCH AND SARAH P. CHOATE. *Jour. Frank. Inst.*, **210** [6], 793–804 (1930).—In three materials, silica, granite, and calcite, the degree of polarization of the Tyndall beam was found to be a function of the arithmetic mean diameter of the material. The effect of birefringence was noted but not studied quantitatively. For complete definition of particle size both strength and polarization of beam must be used. Results lie within 10% of exact microscopic measurements made on individual particles in samples. M.A.E.

Contribution to study of effect of elliptical polarization upon energy transmission. R. V. BAUD. *Jour. Opt. Soc. Amer.*, **21**, 119–23 (1930).—This paper gives the equation of the energy transmission in a polarized light equipment that is composed of lenses, two crossed polarizing prisms, two crossed mica plates in 45° position with respect to the prisms, and a light source that produces white light. The equation is especially of interest to those working on problems of optical stress. H.I.

Measurements of thermoluminescence of glass exposed to light. R. E. NYSWANDER

AND BYRON E. COHN. *Jour. Opt. Soc. Amer.*, **20**, 131–36 (1930).—Thermoluminescence of ordinary glasses when heated to temperatures above 100°C and after exposure to sunlight or to the light of carbon or mercury arcs was measured with a polarization photometer. Glass which had turned violet in color due to long exposure to the sun's rays showed a marked thermoluminescence when heated to temperatures above 100°. Some uncolored glasses exposed to sun's rays or to the carbon or mercury arc also showed luminescence. Special glasses were also made from a chemically pure zinc borate glass to which was added a trace of one of the following metals, Ba, Ca, Sr, Mg, Mn, Al, Ni, Co, Cr, Ag, Ce, Tl, and Th. Each of the above was exposed to sunlight, the most luminescent being Th, Ce, Ag, Cr, Co, and Mn glasses. The following curves were determined; growth of luminescence with time of exposure, both for sunlight and the carbon arc, effect of concentration of solute, decay of thermoluminescence, and periodic changes of luminescence as dependent upon time after excitation. See also *Ceram. Abs.*, **9** [12], 1032 (1930). H.I.

Ceramic glass. II. Salts of silicic acid. OSCAR KNAPP. *Tonind.-Ztg.*, **53** [104], 1821 (1929); for abstract see *Ceram. Abs.*, **9** [11], 944 (1930). M.V.K.

Spectral reflectances of common materials in the ultra-violet region. M. LUCKIESH. *Jour. Opt. Soc. Amer.*, **19**, 1–6 (1929).—Spectral reflectances were measured in the region 2400 to 5800 A.U. using the photoelectric cell method. The results are presented graphically and include among others those for dry pigments such as white lead, tin oxide, lithopone, "titanium" pigment, zinc oxide, and dry powders such as magnesium carbonate, slaked lime, wall plaster, kaolin, aluminium oxide, "pulverized silica," opal glass, and graphite. Among the pigments white lead is far superior to tin oxide, lithopone, titanium, and zinc oxide in the region 2800 to 3200 A.U. Zinc oxide is desirable where a high reflectance in the visible and absorption in the ultra-violet is required. Magnesium carbonate, silica, slaked lime, and wall plaster have high reflectances in the ultra-violet. Aluminium oxide and kaolin are somewhat lower in the shorter wave-lengths and the reflectance of opal glass drops off very much as the wave-length decreases. H.I.

Mechanism of plastic flow. G. E. CUNNINGHAM. *Jour. Phys. Chem.*, **35** [3], 796–814 (1931).—On centrifuging clay suspensions at different velocities, a curvilinear relationship was found between water retained and centrifugal force or pressure exerted on the gelatinous material. The experiments seem to justify the conclusion that the property of plasticity is due to the ability of the plastic material to undergo a change in mobility under the influence of an applied pressure which may be entirely independent of the shearing force. G.R.S.

Plastic flow measurements. G. W. SCOTT BLAIR. *Pottery Gaz.*, **56** [644], 241–43 (1931); for abstract see *Ceram. Abs.*, **10** [3], 224 (1931). E.J.V.

Liquid immiscibility as exemplified by borate and silicate melts. LOUIS NAVIAS. *Glass Ind.*, **12** [2], 38–39 (1931).—The phenomenon of immiscibility was first explained, using liquids and then glasses as examples. Borate glasses and silica glasses behave much alike; those oxides that mix in all proportions with silica are apt also, in general, to mix in all proportions with boric acid. Such oxides are, notably, soda, potash, and alumina. Those that in some proportions or other are apt to form two liquids are such oxides as lime, strontium oxide, and magnesia. Barium oxide hovers between the two and apparently some uncertainty exists as to its exact status. Iron oxide (FeO) in the ferrous condition is miscible, but the ferric oxide is so unstable that its behavior is not yet known. Many of the coloring oxides, such as cobalt, are apt to form two liquids and the combinations of two liquids produce a turbid glass, droplets of one liquid being dispersed through the other. This condition can often be frozen in and obtained at room temperatures. In all cases the immiscibility or formation of two liquids in the melt

takes place only for certain proportions of the two oxides. In the case of barium, the range in which it is immiscible is quite short, while in the case of the alkaline earths other than barium, the range of immiscible mixture is long. E.J.V.

Immersion liquids of low refraction. V. F. HARRINGTON AND M. J. BUERGER. *Amer. Mineralogist*, **16** [2], 45–54 (1931).—Fractionating and determining the indices of the lower petroleum distillates gives a series of ideal immersion media with indices lower than 1.45. They are stable, do not dissolve inorganic compounds, and may be obtained with almost any index without mixing. The index is constant on evaporation. The commercial distillates used were petroleum ether, two ligroin's gasolene, and kerosene. Tables and graphs indicate concisely the results obtained. G.R.S.

Refraction of a liquid between two thin prisms. MORTON MASIUS AND W. E. LAWTON. *Jour. Opt. Soc. Amer.*, **20**, 271–78 (1930).—The effect of departure from true parallelism of the glass plates forming the sides of a hollow prism upon the value determined for the refractive index of the enclosed liquid by the minimum deviation method is discussed. Assuming the prism angle as approximately 60° and the indices of liquid and glass to be within the normal range, it is demonstrated that if the sum of the departures of both plates from true parallelism is not more than one second, the error will not be more than 3 units in the 6th decimal. If the sum of the departures from parallelism is of the order of one minute then the index of refraction may be in error by 1 or 2 units in the 4th decimal. H.I.

Crystal structure of the series of barium and strontium carbonates. J. M. CORK AND S. L. GERHARD. *Amer. Mineralogist*, **16** [2], 71–77 (1931).—Using the powder method a study was made of the effect upon the lattice constants of barium carbonate by addition of definite molecular fractions of strontium carbonate. The mixtures examined were of two kinds (*a*) mechanical and (*b*) precipitated. In the former case each component shows its own definite pattern while in the latter only a single intermediate pattern is observed obeying approximately the additive law of Vegard. The effect of heating the pure and mixed carbonates during X-ray exposures was investigated. Spectrometer measurements on barium carbonate indicate that the previously reported dimensions of the unit orthorhombic cell must be somewhat modified. G.R.S.

Ternary system $CaO(CO_2)SiO_2$ and hardening of mortar. GUSTAV F. HUTTIG AND EMIL ROSENKRANZ. *Z. Elektrochemie*, No. 35, pp. 308–14; reviewed in *Chem. Zentr.*, No. 21, p. 2715 (1929); *Tonind.-Ztg.*, **53** [102/103], 1804 (1929); for abstract see *Ceram. Abs.*, **9** [9], 710 (1930). M.V.K.

Magnetic susceptibility and chemical investigation. JAMES F. SPENCER. *Chem. & Ind.*, **50** [5], 37–41 (1931).—One of the earliest uses of magnetic susceptibility was in the control of the fractionation of mixtures of the rare earths. Other applications are discussed and numerous graphs are shown. G.R.S.

Deflocculation theory and practice. ANON. *Ceram. Ind.*, **16** [3], 281–82 (1931).—The theory of deflocculation is presented and the composition range of sodium silicate is given with the effect of the various compositions on the deflocculation of casting slip. The use of sodium carbonate, sodium hydroxide, and combinations of electrolytes is discussed. W.W.M.

Origin of pinholes in cast ware. GERHARD BUDEWIG. *Keram. Rund.*, **38**, 215–16 (1930).—An important cause of pinholes is the high viscosity of slip which does not permit the release of air bubbles entrapped during blunging. A simple pipette viscosimeter is adequate for the plant control of vicosity, a relative value for viscosity being obtained by the ratio of discharge time for the slip to discharge time for pure water. Increase in viscosity of casting slip is often due to the introduction of soluble electrolytes either from the raw materials themselves or from the mill water. H.I.

Carborundum fractionating columns. ESTHER C. FARNHAM. *Jour. Phys. Chem.*,

35 [3], 844–58 (1931).—Tests on materials as a column filling indicate that silicon carbide and micaceous hematite are better than glass beads. Thin plates of silicon carbide are better than needles. G.R.S.

Measurement of gloss. A. H. PFUND. *Jour. Opt. Soc. Amer.*, **20**, 25–26 (1930).—The specular reflection which determines objective gloss is measured by mounting samples on a cylinder which is spun rapidly to eliminate the effect of surface irregularities. Large angles of incidence of the light are employed. The brightness of the image of a source reflected specularly from the cylindrical sample is photometered by means of an optical pyrometer. Actual results show that gloss so measured is independent of the brightness of the background. Continuous sheets, fabrics, threads, and pigments or powders may be thus measured. H.I.

Color reaction of Japanese acid clay upon carotin. K. KOBAYASHI, K. YAMAMOTO, AND J. ABE. *Chem. News*, **142** [3694], 66 (1931).—Japanese acid clays, previously dried at 100 to 150°C give a bluish-green color reaction upon carotin benzol solution. The color reaction was studied with 35 samples of clays, 15 being Japanese acid clays, 3 Florida clays, and 1 fullers' earth. G.R.S.

Maintenance of a standard of electromotive force: notes on standard Weston cells. A. NORMAN SHAW AND H. E. REILLEY. *Can. Jour. Research*, **3** [5], 473 (1930).—A detailed procedure for the maintenance of a standard of voltage to within one or two parts in a million is described. Neutral saturated cells have been found to be superior to acid cells as independent standards for a period of many years, though the latter are preferable for purposes of ordinary precision or shorter periods. A summary of data on standard cells is included. W.L.

Dielectric constant and structure of thixotropic sols. S. S. KISTLER. *Jour. Phys. Chem.*, **35** [3], 815–29 (1931).—Hypotheses of the origin of thixotropy in gels are reviewed and the assumption that hydration is at least a contributory cause is favored. Thixotropy is most readily explained by the assumption that some form of orientated anisotropy of the water, probably chains of water molecules, extends out from the surface of each colloidal particle and tends to link it to adjacent particles. G.R.S.

BOOKS AND BULLETIN

Elements of Chemical Engineering. WALTER L. BADGER AND WARREN L. MCCABE. Introduction by Arthur D. Little. 625 pp., 314 figs. + appendices. Price, $5.00. McGraw-Hill Book Co., New York, 1931. Reviewed in *Gas Age-Rec.*, **67** [10], 348 (1931); *Can. Chem. Met.*, **15** [2], 52 (1931).—In striking contrast to older manuals in which involved reaction equations and flow sheets of industrial processes formed the basis of discussion, emphasis in the present book is placed on the modern concepts of chemical engineering which are readily accessible. Cross-sectional line cuts of operating equipment are included. E.J.V.

Condensed Outline of Modern Physical Chemistry. FREDERICK HURN CONSTABLE. 153 pp. Price 10s 6d. Ernest Benn, Ltd., London. Reviewed in *Gas Age-Rec.*, **67** [10], 348 (1931).—Up-to-date scientific fact and theory are presented in condensed and ready form. The treatment is mathematical rather than descriptive, numerous derivations being given. The list of chapter headings is as follows: Dynamical Theory of Matter, Laws of Chemical Combination, Thermochemistry, Solution, the Phase Rule, Osmotic Pressure, Methods of Molecular Weight Measurement, Dissociation in Gases, Theory of Electrolytic Dissociation, Law of Mass Action, Application of Thermodynamics to Strong Solutions, Surface Chemistry, Colloid Chemistry, Catalysis, Chemical Affinity, Electrochemistry, Structure of Atoms, Solid State, and Photochemistry. The chapters on Catalysis, Structure of Atoms, and Photochemistry are excellent as brief descriptive accounts of these subjects. E.J.V.

Simple Practical Chemistry for Ceramists, Glass Technologists, Metal Technologists, etc., for Use in Trade and Professional Schools and for Self-Instruction. (Einfaches Chemisches Praktikum für Keramiker, Glastechniker, Metalltechniker, usw., zum Gebrauch an Fachschulen, Gewerbeschulen und zum Selbstunterricht.) EDUARD BERDEL. Verlag des Sprechsaal, Müller and Schmidt, Coburg, 1930. Price 6 M. *Z. angew. Chem.*, **43** [52], 1150 (1930).—A special word of recommendation for this new work of Berdel's is not necessary. As an experienced practical man and teacher he has put out a book containing descriptions of the most important analytical processes used by industry and has so described them that any one wishing to apply them may do so without the necessity of referring to other volumes on the same subject. Especially valuable is the practical angle which he has applied in the examination of the critical points in analytical studies. L.T.B.

Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. X. J. W. MELLOR. Longmans, Green & Co., N. Y. 958 pp. Price $20.00. Reviewed in *Mining & Met.*, **12** [291], 18 (1931).—This volume of this treatise affords an exhaustive account of the chemistry of sulphur and selenium. Numerous bibliographies add to the value of the book. For Vol. IX see *Ceram. Abs.*, **8** [5], 373 (1929). E.J.V.

Table for Determining Porosity in Per Cent by Volume. HERBERT LUDWIG. H. Ludwig, Mannheim-Friedrichsfeld, Baden, 1931. Rm. 1.00. Reviewed in *Sprechsaal*, **64** [3], 57 (1931).—This table facilitates greatly the determination of porosity in per cent by volume and the corresponding absorption of water in per cent by weight and specific gravity. The description and explanation of the table is given in English, French, and German. The table is especially valuable to manufacturers of stoneware, white ware, porcelain, glass, refractories, cement, and cement ware. M.V.K.

Annual Tables of Constants and Numerical Data. Table of Contents, Vols. 1–5; 1910–1922. (Tables Annuelles de Constantes et Données Numériques. Table des Matières, V. 1–5; 1910–1922.) ANON. Gauthier-Villars et cie., Paris; McGraw-Hill Book Co., N. Y. 382 pp. Price $20.00. Reviewed in *Mining & Met.*, **12** [291], 18 (1931).—This index contains analytic, alphabetic, and formula indexes to the first five volumes of the Tables, thus making it a simple matter to find what is wanted, and making the set much more useful than it has been. See also *Ceram. Abs.*, **9** [12], 1104 (1930). E.J.V.

Thermoelectric Temperature and Heat Flow Measurement. (Die thermoelektrische Temperatur und Wärmeflussmessung.) E. RAISCH AND K. SCHROPP. Forschungsheim für Wärmeschutz, E. V., Münich. 93 pp., 39 illustrations. Reviewed in *Messtechnik*, **6** [9], 249–50 (1930).—This is an invaluable book for the engineer desiring information on the various methods in use for measuring temperature and heat flow, as it is concise but complete. E.J.V.

Practical Qualitative Analysis. (Ausfuhrung Qualitativen Analysen.) WILHELM BILTZ. Akademische Verlagsgesellschaft m.b.H., Leipzig, 1930. Price 8.50 M. *Z. angew. Chem.*, **43** [4], 914 (1930).—This new edition of Biltz's qualitative analysis is conveniently arranged and well edited. Technical analysis, according to the model of Clemens Winkler, has received model treatment in the volume. L.T.B.

Quantitative Organic Microanalysis. F. PREGL. 2nd English ed. Translated from the 3rd revised and enlarged German edition by E. Fyleman. 237 pp. J. and A. Churchill, London, 1930. Reviewed in *Chem. & Ind.*, **50** [4], 73 (1931). G.R.S.

Industrial application of the X-ray. ANON. *Metal Prog.*, **19** [1], 142 (1931).—Bulletin No. E-3 of the General Electric X-Ray Corp. explains the value of X-rays in various industrial processes and describes the apparatus required for this work. Fifty selected radiographs are illustrated. E.P.R.

X-Ray Technique in Testing Materials. J. EGGERT AND E. SCHIEBOLD. Reviewed

in *Mining & Met.*, **12** [291], 18 (1931); *Z. phys. Chem.*, **151** [3], 309 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1104 (1930). E.J.V.

PATENTS

Purification and treatment of clay. WILLIAM FELDENHEIMER. U. S. 1,791,959, Feb. 10, 1931. In the treatment of clay, the steps consisting of deflocculating a liquid suspension of the clay, separating out impurities, flocculating and thickening the slip with reagents in quantities which render the slip nonacidic, and thereafter removing the clay from the liquid.

Making titanium dioxide. SIMON J. LUBOWSKY. U. S. 1,793,501, Feb. 24, 1931. In the manufacture of titanium dioxide from rutile, the process of which comprises heating a finely-ground mixture of rutile and magnesia to form a magnesium titanate, acidifying with sulphuric acid and dissolving in water, chilling the solution to deposit magnesium sulphate, removing the mother liquor, and heating it to a high temperature to produce metatitanic acid by hydrolysis and regain sulphuric acid.

Titanium dioxide. I. G. FARBENIND. A.-G. (Friedrich Raspe and Paul Weise, inventors.) Ger. 504,843, Sept. 2, 1928. Ti ores are treated with H_2SO_4 to separate TiO_2. The residue is subjected to a mechanical flotation and returned to the H_2SO_4 treatment. (*C.A.*)

Treating titanium ores. I. G. FARBENIND. A.-G. (Heinrich Plaut, inventor.) Ger. 508,110, May 7, 1927. The mixture obtained by opening up Ti ores in the usual way with H_2SO_4 is treated with the sulphate or other salt of an alkali metal or NH_4 in order to convert the Ti into a titanium-alkali or -ammonium sulphate. The double sulphate is more stable to heat than $Ti(SO_4)_2$, and the mixture may accordingly be warmed until all the Ti has dissolved and then filtered and cooled to crystallize the double sulphate. Additional details and an example are given. (*C.A.*)

Zirconium ores. KALI-CHEMIE A.-G. (Friedrich Rüsberg and Paul Schmid, inventors.) Ger. 509,514, Dec. 14, 1926. Zr ores are disintegrated by heating to glowing with lime and earth-alkali oxide, carbonate, or hydroxide to form a good flux. The process is preferably carried out in a rotary reverberatory furnace in the presence of steam. In the example, ore containing 75% ZrO_2 and 15% SiO_2 is heated with fluorspar and $CaCO_3$ to 1200° in a tube furnace. (*C.A.*)

General

Influence of lime on earthenware clays. O. KRAUSE. *Ber. deut. keram. Ges.*, **11** [7], 379 (1930).—Contribution to the knowledge of the sintering reaction and the constitution of ceramic mixtures. Third note: K. examined the influence of lime on earthenware clays during the different firing stages and tested the chemical, physical, and structural changes and reactions taking place. The three tested mixtures contained 20–10–0% lime, always 45% clay substance, and a varied amount of quartz. In these mixtures, at only above 800°C, a certain dissolution of the SiO_2 takes place. Between 100 to 400°C none of the three materials contains soluble alumina but beyond 500° the dissolution increases, and decreases at 800°. Between 500° and 800° large quantities of alumina are dissolved; above, the solubility becomes lower. Specific gravity, volume-porosity (carbon tetrachloride), and transverse strength are also tested. Furthermore, structural changes are tested by X-ray. From diagrams it can be seen that quartz will not change during the heating process. Mixture 1 will show cristobalite interference at 1200°. Some indication for mullite interference is given but as there is such a large number of interference lines in all the diagrams, it is rather difficult to draw any conclusions. Above 1200° development of liquid phase starts, which seems to in-

fluence the development of cristobalite. At about 900° mullite seems to be developed from the clay substance. All these reactions depend on temperature. I.R.

Hand molding of clay. A. COULTAS. *Refrac. Jour.*, **6** [64], 121–27 (1931).—A joint meeting of the Refractories Assn. of Great Britain, the Clay Trades Technical Society, the Nat. Assn. of Clayworks Managers, the Foundry Trades Technical Soc., and the Sheffield Soc. of Engineers and Metallurgists, was held at the Department of Applied Science, The University, Sheffield. C. delivered a lecture on "The Hand Molding of Clay." E.P.R.

Fundamentals and economies in the clay industries. II. ELLIS LOVEJOY. *Clay-Worker*, **95** [2], 100–101 (1931).—In this chapter the causes of failure are discussed. They are enumerated as follows: (1) lack of experience, (2) extravagance in construction costs, (3) insufficient initial capital, (4) desultory operation, and (5) the clay itself. Each of these items is taken up in detail. For Part I see *Ceram. Abs.*, **10** [4], 270 (1931). E.J.V.

When municipality is liable for purchase price of clay products. LEO T. PARKER. *Brick Clay Rec.*, **78** [4], 216–20 (1931).—A review is presented of recent court decisions on various points of law in regard to liabilities of a municipality when various materials are purchased. E.J.V.

Effect of grain size on clay bond for molding sands. A. H. DIERKER. O.S.U., *Eng. Expt. Sta. News*, 1930; *Ceram. Ind.*, **15** [2], 220 (1930).—It is advantageous to grind the clay to a certain fineness but not excessively fine. In one case grinding finer than 65-mesh afforded little improvement. W.W.M.

Geological profile the base for the valuation and development of deposits of ceramic raw materials. J. BEHR. *Ber. deut. keram. Ges.*, **11** [7], 415 (1930).—One must distinguish at each cut of a mine between the different kinds of rocks, the age of the layers, the situation of the layers, depth of layer, petrographic development of the deposit, and the water situation in the mountains. B. has proved how necessary it is to take the advice of an experienced geologist when starting to develop a mine or before paying taxes on the property. I.R.

Coöperation of the scientist and practical man in the plant. K. ENDELL. *Ber. deut. keram. Ges.*, **11** [10], 509 (1930).—In this lecture, given before the German Ceramic Society, E. outlines the historical development and the situation today, the relations between these two, the penetration of scientific ideas into the ceramic practices, and the human psychological foundations of coöperation. I.R.

Economics of the nonmetallic mineral industries. I. Introduction. Value of prospects and the factors that enter into that value. RAYMOND B. LADOO. *Rock Prod.*, **34** [5], 44–46 (1931).—L. shows the differences between metal and nonmetal operations. He emphasizes the "place-value" of nonmetal deposits, the importance of available markets, and makes three groups of nonmetallic minerals according to the factors affecting their values. W.W.M.

Purifying and sorting raw materials through washing. V. BUSCH. *Keram. Rund.*, **38**, 199–200 (1930).—Empirical rules for rate of water flow and types of washers to be used for different sizes and kinds of ceramic raw materials are given. H.I.

Men and mines. SCOTT TURNER. Bur. Mines, *Information Circ.*, No. 6418, 6 pp. (1930).—A radio talk which points out our dependence on the work of the miner and briefly describes the studies conducted and the services performed by the Bureau. See also *Ceram. Abs.*, **10** [2], 158 (1931). R.A.H.

Underground mining practice and costs of fluorspar mine at Rosiclare, Illinois. A. H. CRONK. Bur. Mines, *Information Circ.*, No. 6384, 14 pp. (1930).—This report gives the history and development of a property where fluorspar is mined by shrinkage and open-timbered stope methods. See also *Ceram. Abs.*, **10** [2], 145 (1931). R.A.H.

Glue molds, their preparation and use. RAYMOND B. LADOO. *Ceram. Ind.*, **16** [1], 66 (1931).—Makers of ornamental plaster work use two part flexible molds of glue or gelatin, instead of "piece molds" of plaster. L. describes the making of the glue mold from a model, the use and care of this type of mold, and says that it has a possible use in the clay-forming industries. Glue molds will not stand temperatures above 140°F, but if properly cared for, are long lived. W.W.M.

Brick paving engineers discuss construction. ANON. *Eng. News Rec.*, **106** [7], 293 (1931).—Pavement bases, bedding courses, and joint fillers occupy chief place in discussion at meeting of Manufacturers Assn. W.L.

Clay products extensively used in Detroit-Canada tunnel. ANON. *Brick Clay Rec.*, **78** [4], 192 (1931).—Detroit-made common brick, light brown wall tile, and a mat texture red wall tile were used extensively in the tunnels and buildings which make up the Detroit-Windsor Tunnel project. Illustrated. E.J.V.

How to sell brick other than on a price basis under present market conditions. W. F. SCHLAKE. *Clay-Worker*, **95** [2], 106–107 (1931); *Brick Clay Rec.*, **78** [3], 150–52 (1931).—The need of developing a sales organization capable of presenting the story of brick intelligently and convincingly is pointed out, and a number of incidents from the experience of the Illinois Brick Co.'s sales organization are cited. E.J.V.

How to make profits in the brick business under the present reduced volume. ROBERT D. HAMILTON. *Clay-Worker*, **95** [2], 107–108 (1931); *Brick Clay Rec.*, **78** [3], 150 (1931).—H. believes the first essential to making profits in these times is through effective coöperation along the following lines: (1) regulate production according to sales, (2) establish reasonable and fair prices, then stick to them, (3) avoid raiding competitors' markets and customers, and (4) take the jobs which belong to you and let your competitor have those which belong to him. E.J.V.

Development of new uses for brick. T. R. LAWSON. *Clay-Worker*, **95** [2], 108–10 (1931); *Brick Clay Rec.*, **78** [3], 152 (1931).—The need for more definite knowledge of brick possibilities is stressed and some of the investigational work that has been carried on is cited. E.J.V.

Keynote address. WILLIAM G. PRICE, JR. *Clay-Worker*, **95** [2], 104–105 (1931); *Brick Clay Rec.*, **78** [3], 140–42 (1931).—In an address delivered at the C.B.M.A. meeting, P. points out that the greatest obstacles to the common brick industry are (1) the use of substitute products because they are promoted by a more progressive and uncombated salesmanship; and (2) a lack or failure of promotional effort urging a greater use of brick. He also gives ten points of a policy that might be taken up by individuals or a group to their advantage in advancing their interests. E.J.V.

National Paving Brick Manufacturers' Assn. ANON. *Brick Clay Rec.*, **78** [3], 158–60 (1931); *Clay-Worker*, **95** [2], 118–19 (1931).—The 25th anniversary meeting was at Pittsburgh. E.J.V.

Education of glass technologists. F. W. PRESTON. *Glass Ind.*, **12** [3], 60 (1931).—The need for educated men in the glass industry is stressed, but it is pointed out that the subject of glass technology is too narrow to warrant degrees being granted therein, though it would be well to make it a post-graduate research course for graduates in some broad field of science. E.J.V.

Proposed factory to have no windows. ANON. *Abrasive Ind.*, **12** [1], 37 (1931); for abstract see *Ceram. Abs.*, **10** [3], 182 (1931). E.P.R.

Glass backstops aid view of basketball. ANON. *Popular Sci.*, **118** [4], 47 (1931).—Plate glass backboards replacing wooden have no effect on play but permit greater visibility of all points of the game of basketball. Illustrated. E.J.V.

January production of polished plate glass. P. A. HUGHES. *Glass Ind.*, **12** [3], 66 (1931).—The production of polished plate glass for January, 1931, was 7,320,675

sq. ft., compared with 10,017,909 sq. ft. produced in January, 1930, and 4,941,405 sq. ft. in December, 1930. See also *Ceram. Abs.*, **10** [4], 262 (1931). E.J.V.

Canada's nonmineral production, 1930. W. H. LOSEE. *Can. Chem. Met.*, **15** [2], 28 (1931).—Official estimates of nonmetals for 1930 are as follows: feldspar, 26,000 T. valued at $266,000; gypsum 1,060,000 T. at $2,875,000; mica, 1200 T. at $110,000; quartz, 2000 T. at $400,000; and clay products valued at $10,000,000. All these items show a decrease from the 1929 record output. E.J.V.

Ceramic industry of Ontario. ROBERT J. MONTGOMERY. *Clay Prod. News*, **4** [1], 5 (1931); for abstract see *Ceram. Abs.*, **10** [4], 313 (1931). W.C.O.W.

Canadian clay industry. DOMINION BUREAU OF STATISTICS. *Pottery Gaz.*, **56** [644], 223 (1931); for abstract see *Ceram. Abs.*, **10** [4], 311 (1931). E.J.V.

Ceramic division gives service. ANON. *Clay Prod. News*, **4** [1], 11–13 (1931).—The Ceramic Division of the Mines Branch, Ottawa, details some of its services to the Canadian ceramic manufacturers. W.C.O.W.

Ceramic industry of Nova Scotia. ANON. *Clay Prod. News*, **4** [1], 14 (1931).—A list of the ceramic manufacturers of Nova Scotia, the products which they manufacture, and production statistics for the last four years are given. W.C.O.W.

Ceramic raw materials in Italy. F. SAVELLI. *Ind. Silicati*, **8** [12], 14–15 (1930).—Italy is forced to import a large proportion of raw materials for ceramic industries because of the lack of initiative in developing and studying natural resources and because of the lack of adequate protection against foreign products. See also *Ceram. Abs.*, **10** [1], 64 (1931). M.V.K.

Ceramic industries must be represented at 1933 World's Fair in Chicago. ANON. *Nat. Glass Budget*, **46** [43], 5 (1931).—That the ceramic industries, of which glass is an important one, should be represented at the Chicago World's Fair in 1933, is an undebatable fact. A good start along the line of arousing interest and actually accomplishing this task has been made by Edward Orton, Jr., Ross C. Purdy, Secretary of the AMERICAN CERAMIC SOCIETY, and others. E.P.R.

Pacific Northwest Section of A.C.S. has interesting meeting. ANON. *Brick Clay Rec.*, **78** [4], 192 (1931).—A report of the papers read and items discussed at the meeting at the University of Washington, January 30, 1931, is given. E.J.V.

C.B.M.A. convention in Philadelphia. ANON. *Brick Clay Rec.*, **78** [3], 138–56 (1931); *Clay Worker*, **95** [2], 102–103 (1931).—A general report of the meeting held in Philadelphia, February 2 to 6, 1931, is given. E.J.V.

Structural Clay Tile Association meeting. ANON. *Brick Clay Rec.*, **78** [4], 193–96 (1931).—The third annual convention was held in Chicago on February 19 and 20, 1931. E.J.V.

Everyday ceramics. HOWELLS FRÉCHETTE. *Bull. Amer. Ceram. Soc.*, **10** [3], 68–71 (1931); *Brick Clay Rec.*, **78** [3], 135 (1931).—This was a radio address delivered over a number of Canadian stations on Feburary 5, 1931. E.J.V.

Promoting ceramic art, science, and technology in America. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [2], 28–29 (1931).—After pointing out some of the economic considerations that are having their effects on various branches of the ceramic industry, it is pointed out that it would seem imperative that these economic ceramic questions be brought up for constructive thinking by those who are pledged to coöperation in the promotion of ceramic art, science, and technology. E.J.V.

To whom are you indebted? EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [3], 55–56 (1931).—Through a series of questions touching on various fields of human experience it is developed that individual effort and thinking is not sufficient but if made a part of a collective endeavor more individual and collective benefits are reaped. This is

made particularly applicable to membership and collaboration in the ceramic field and the AMERICAN CERAMIC SOCIETY. E.J.V.

From dirt to wealth. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [2], 27–28 (1931).—Clay and other mineral powders are dirt in one meaning of that word, but are not dirt when used in production of ware. Through proper combination of these materials and treating them to a firing treatment certain chemical-physical and pyro reactions are entered into which result in the production of useful ware from these mixtures of silicates. Ways in which various results are effected are briefly touched upon. E.J.V.

BOOKS

Encyclopedia of Ceramic Industries. I, II, III. A. B. SEARLE. E. Benn, Ltd., London, 1930. Reviewed in *Keramos*, **10** [1], 27 (1931).—All phases of the ceramic industries and applied fields are treated in alphabetical order with historical and artistic comments. Bibliography and references are carefully compiled. Numerous illustrations show the cultural development of different nations. M.V.K.

Ceramic Trade Directory of the Whiteware Industries. ANON. The Ceramics Publishing Co., Newark, N. J. 2nd ed. 176 pp. $5.00. Reviewed in *Mining & Met.*, **12** [291], 14 (1931).—This directory lists over 500 companies in the U.S. and Canada that are engaged in the whiteware branches of the ceramic industry. It is adequately indexed and subdivided and should be a useful work of reference. E.J.V.

Textbook of Ceramics. HERMANN HECHT. Reviewed in *Z. angew. Chem.*, **43** [52], 1150 (1930); for abstract see *Ceram. Abs.*, **10** [1], 80 (1931). L.T.B.

A.S.T.M. Tentative Standards. AMERICAN SOCIETY FOR TESTING MATERIALS, 1930. *Mech. World*, **89** [2301], 132 (1931).—This recently published 1930 edition of the A.S.T.M. volume on Tentative Standards contains 155 suggested standards relating to a wide range of subjects, among which may be mentioned ferrous metals, nonferrous metals; cement, lime, gypsum, and clay products; preservative coatings and petroleum products; road and paving materials; coal and coke, shipping containers, slate, and miscellaneous materials. The volume also contains tentative revisions in 35 existing A.S.T.M. standards. It may be noted that the term "Tentative Standard" as distinguished from "Standard" is applied to a proposed standard which is printed for one or more years with a view of eliciting criticism, of which the committee concerned will take due cognizance before recommending final action toward the adoption of such tentative standards by formal action of the Society. E.P.R.

Index to A.S.T.M. Standards. ANON. *Rock Prod.*, **34** [4], 39 (1931); for abstract see *Ceram. Abs.*, **10** [4], 312 (1931). W.W.M.

PATENT

Manufacture of vitreous material. PERCY BROADBENT CROSSLEY. U. S. 1,795,200, March 3, 1931. Making a plastic composition which comprises mixing colloidal mica, colloidal asbestos, refractory ceramic material infusible below 900°C, and metallic flux material fusible below 700°C and molding the mixture.

Book Review

First Communications of the New International Association for the Testing of Materials. Zurich, 1930. Reports of Group A (Metals). 368 pp. **Reports of Group B (Nonmetallic Inorganic Materials).** 282 pp. Verlag N.I.V.M., Zurich. The New International Association for the Testing of Materials, founded in Amsterdam in 1928, holds its next meeting in Zurich in 1931. In the course of selection of the subjects for discussion at the 1931 meeting, the committee attempted to collect a series of brief

reports covering the "state of the art" on the various aspects of materials testing. While the collection was incomplete, only 37 out of 66 subjects on nonmetallic inorganic materials that were invited becoming available in time for publication, these "Interim Reports" are presented as giving some idea of the status of materials testing throughout the world.

The reports are printed in English, German, and French, and prefatory abstracts are given in all three languages. Besides the two volumes reviewed here, two other volumes, one on organic materials (group C) and one on questions of "general interest" are to be issued.

The individual reports are not long, averaging about 8 pages. The volume on metals contains little of direct interest to the average ceramic engineer but covers a wide range of subjects of interest to metallurgists. The one on nonmetallic, inorganic materials is almost wholly devoted to cement and concrete. Eighteen of the reports in it are in German, twelve in English, and seven in French. The authors are, as a rule, connected with public institutions, either government testing laboratories, group laboratories, or educational institutions. The structure and properties of and testing methods for natural and artificial building stone and road ballast are discussed in seven papers. Cement and concrete are dealt with in twenty-seven, while ceramic testing receives attention in only two. The contributions from the U.S. are by W. A. Kessler, A. T. Goldbeck, W. A. Slater, P. H. Bates, and F. E. Richart. The countries represented are Austria, Belgium, Canada, Czechoslovakia, Denmark, England, France, Germany, Holland, Italy, Russia, Sweden, Switzerland, and the U.S.

A bird's-eye view is thus afforded of recent advances in cement testing methods and of the properties found, which experts from the various countries think worth recording.

The two articles on ceramics are "Tests on Ceramic Materials," in German, by O. Kallauner of the Czechoslovakian Institute for Silicate Industries, and "Methods of Testing Ceramic Materials," in French, by R. Barta of the Polytechnic School of Prague, Czechoslovakia. These amount to little more than a mere listing of the names of the tests used in evaluation of raw materials for making refractories or ceramic bodies, or the finished products. The discussion is so sketchy that almost no real idea is gained of the test methods used.

H. W. GILLETT

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Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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Vol. 10 **May, 1931** **No. 5**

EDITORIAL

FEDERATION OF INTERESTS

The United States of America, a noble experiment, highly successful, fraught though it has been by contentions. Secession? No one would now think of secession. Profitable? Its success has inspired the statesmen of Europe to move to this same sort of federation of European countries.

With examples on all hands and in all sorts of human endeavors of the benefits which accrue from federations, and with abundant examples of the utter futility of separate operation of single firms or groups of firms which have common interests, it would seem that smart successful business men would long ago have acted on the principle that for what one association can accomplish there should be no more than one association.

The ceramic industries now have a separate trade association for each distinct type of product. They could and should be federated. This is just as feasible for trade as this SOCIETY has proven it to be feasible in the promotion of their distinct as well as in their common interest in ceramic art, science, and technology.

Having separate trade associations is a waste of money, time, and effort.

Divided, as now, their efforts are nowhere as effective and commanding as they would be if they were federated into one organization with divisions for each product. Divided, as at present, the ceramic interests are without impressive power to obtain helpful and to combat inimical legislation; divided they are not improving opportunities to use the research facilities and to acquaint the pupils in universities with the service possibilities of ceramic ware; divided they are unable to secure their share of governmental and semipublic appropriations for research which the ceramic industries, on the basis of their combined industrial value, are warranted in having devoted to ceramic investigations; and separated, try as they will, the several ceramic groups cannot effectively work together on any program designed to acquaint the public with the superior merits of ceramic ware.

Concrete for sewers, concrete poured and in form of blocks for construction and paving, and imported art and tableware will continue to be used in spite of their inferiority until the ceramic trade groups federate their now separately operating associations into a united Association of Associations.

The market demand for industrial ceramic products, such as high-duty porcelains, refractories, and abrasive wheels, has grown apace with the increase in population and with the increase in mechanization. But not so with ceramic building, paving, drainage, and household ware, excepting glass for windows and porcelains for bath rooms. The domestic pottery and glass are not purchased today in amounts much greater than twenty years ago in spite of the decided superiority of this ceramic ware.

What is wrong with the situation? We, the ceramists of America, should unite for the purpose of obtaining a belief in superior service of each other's products, and unitedly telling the purchasing public of the advantages of using home-made ceramic ware.

ACTIVITIES OF THE SOCIETY

OUR PRESIDENT, A DANE WHO CAME AND STAYED[1]

Why and How I Became An American

By E. V. Eskesen[2]

In the February issue of *World's Work* there appears an article written by E. V. Eskesen, of 113 Water Street, this city, entitled "A Dane Who Came—And Stayed." The account gives briefly an outline of the local man's life prior to the time he became a successful terra cotta manufacturer. This article follows.

It was out on wind-swept, treeless, heather-covered Jutland that I was born. I loved that country; but, perhaps it was the whisperings of sea-roving, Viking ancestors, I always had a longing for getting out, out in the world. I often thought of lands and people that enjoyed milder climates and more favorable conditions. The place that I wanted to see more than all others was sunshiny, jolly Italy.

But I stayed in Denmark. My twenty-third birthday found me holding a clerical position in Copenhagen, a good enough position, somewhat above the average. I might have got on and worked my way up; but at the time, my position did not look to me as holding any possibility of future independence.

In the years of which I speak—the 'eighties and early 'nineties—there were imposed upon the people of Scandinavia, especially of Denmark, certain political restrictions which, to the free-spirited, made life seem unbearable. Then there were all the old conventions of caste, the old social hindrances that almost irresistibly held down a man of humble parentage. These political and social conditions were largely responsible for the big emigration from Denmark during the 'eighties and early 'nineties. It should be added, however, that since then these conditions have entirely changed.

In our school-books, we Danes read about Washington, Franklin, Lincoln, Grant—names from out a new world, names that lighted up the Western Hemisphere. From articles in newspapers, but more particularly from tales brought back by returned emigrants, our minds were fed with the idea of America as the great and rich country where opportunity awaited all.

Three brothers and a sister had gone to America, and were writing me, urging that I follow. And so it came that, at the age of twenty-three, I decided to emigrate to the United States. Like the majority of Danish emigrants, I did not regard the emigration as a permanent thing; I was simply going to America, for an unknown number of years, for the purpose of making money, and then returning to my home—to Denmark—to live and die. I was interested in music, art, literature, particularly in literature, in poetry. In Denmark, though I was only a clerk and had only a clerk's income, I could hear good music and find among my associates men who could talk with intelligence and sympathy of art and literature. In America, I knew it would be different: I had heard so much about American materialism and the hunt for the almighty dollar, that I feared that if I stayed permanently in America, my better belongings should be submerged in the maelstrom of materialism.

After settling my affairs and paying for my equipment, there was very little left of the money which I had been able to raise; so I decided that inasmuch as I had to start from the bottom when I got to America, I might just as well begin with the beginning—I bought a steerage ticket.

I went by way of Great Britain, sailing from Glasgow on an old steamer that took eighteen days to cross the Atlantic. But the trip was joyous enough. There were a few Danes, and many Scotch and Irish, the latter coming aboard when the ship touched at Londonderry. The good company and the long trip combined to make my small treasure dwindle away; I had only one dollar left when finally we came in sight of America. It was an afternoon in April, 1891. I remember distinctly the eagerness with which we all had been gazing shoreward to see the first gleam of the promised land. When the shore and green hills appeared on the horizon, seemingly gliding up out of the ocean toward us, I remember how I isolated myself from the rest of the company, and with eyes fixed on the new land, thought of the future before me and dreamed the dreams of youth and ambition.

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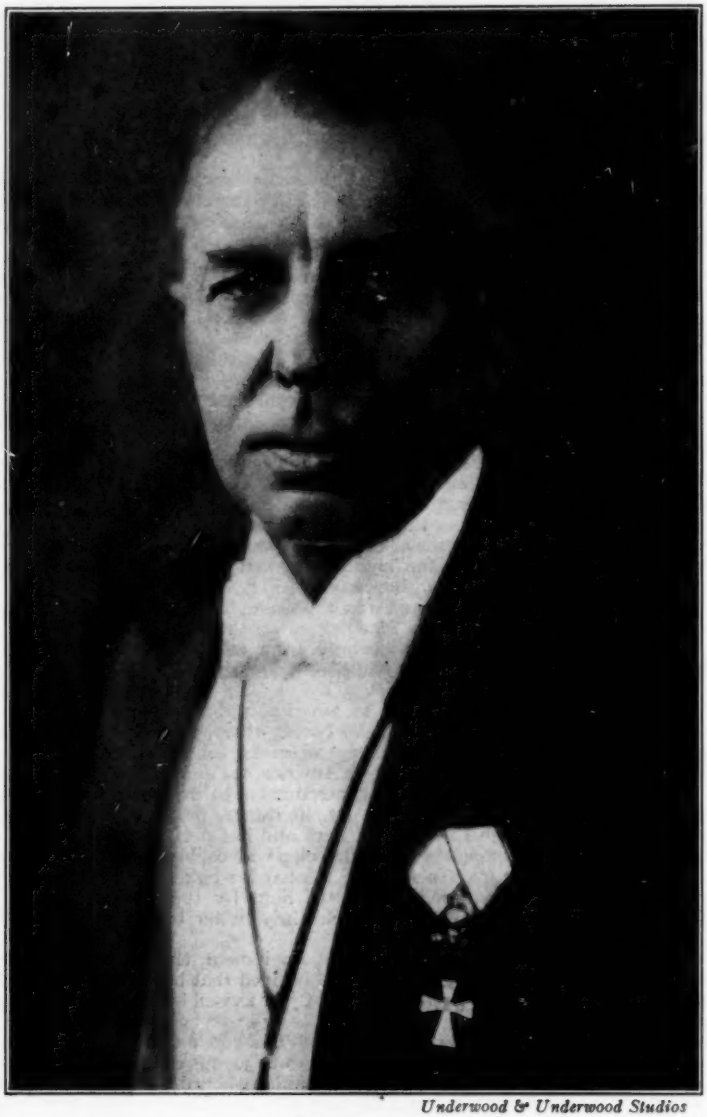
[1] Reprinted from the *Perth Amboy Evening News*, Friday, April 15, 1921.

[2] For "High Honor for E. V. Eskesen," see *Bull. Amer. Ceram. Soc.*, **2** [7], 235 (1923).



Underwood & Underwood Studios

E. V. ESKESEN

It was late evening when we came in through the Narrows and anchored off Tompkinsville for the night. It was unusually warm for the season—just like a beautiful, clear summer night. Some one brought out a concertina; the rest of us lay around on the deck listening to the music. Close to us, from the hillsides of Staten Island, shone myriads of lights. In front of us were Manhattan and Brooklyn joined by the web-like span of the Brooklyn Bridge, all, everything wrapped in light—oceans of light all around us. Indeed, this was fairyland!

The next morning we landed at Castle Garden. I was worried about that single

dollar in my pocket, for the rules at that time required that an immigrant have at least ten dollars. So I made an arrangement with a fellow voyager who was a little better financed than I was; he showed the necessary ten dollars to the inspector, was duly passed, and, once outside the fence, slipped the ten dollars between the pickets of the fence to me on the inside. I, too, was duly passed.

Outside the gate I found my younger brother waiting for me. He had been working in a terra cotta factory. So after looking around for a couple of days we secured work as pressers in an architectural terra cotta plant located in Long Island City. It was hard and unusual work for me, my surroundings rough, ugly, depressing.

The first years of an immigrant's life are always the hardest. These years leave their marks and are never forgotten. For the man who has to fight his way up from the bottom, it is work, work, work—hard, grinding work. But it is not this that leaves its mark—it is the fact that he is made to feel that he is an outsider, a pariah. My early years in America were before the great influx of immigration from South and East Europe. The word "greenhorn" was then very much in use and was applied to anyone who was not born here. It carried with it a stigma, and was meant to hurt.

For me, as for other ambitious immigrants, the first years in America were bare of leisure or recreation. After the hard, manual labor of the day, I went to evening schools to study English, bookkeeping, stenography, and many other things which I found necessary in order to advance myself. It was sometimes two schools in one evening. I had to put aside all those things that represent the finer ideals of life, music, art, literature. I had expected that I would have to give up for a time my writing and poetry; but I had not expected to find my life stripped so absolutely bare of even a reference to these things—the talk around the shop and outside was mostly about baseball and prize-fights—so different from what I had been accustomed to in Denmark.

After about four years of manual labor and study, I found in my selected trade the opportunity for success. The idea of making useful and beautiful things out of clay appealed to me as a happy combination of industry and art, of getting perhaps satisfactorily close to art. I took hold of this thing and stuck to it. The old desires of my boyhood, to rove and adventure, came to me, but I repressed them even though I sometimes felt that in doing so I was bridling part of my better self. I did not, like many of my countrymen, Jacob A. Riis for instance, strike out into the uncertain, wandering from place to place, depending on chance jobs between communing with nature. So my experience as an immigrant is commonplace.

Since business success has brought me freedom from the steady grind, the old longing for adventure occasionally awakens. How carefully now I nurse it to life! And so, in my spare time, I have roamed all over the United States and the continent of Europe. I have been to Italy, that land of my boyhood dreams, and though I found it as sunshiny and jolly as I expected, yet if I were to be born again and had the choice of my birthplace, my choice would lie between two countries—the United States and Denmark.

THE SECRETARY'S LETTERS

2525 N. High Street,
Columbus, Ohio,
April 8, 1931.

General Edward Orton, Jr.,
1445 Summit Street,
Columbus, Ohio.

My dear Professor:

Appreciation of Your Services as President of This Society

Immediately upon returning from Cleveland we had to give our entire time to the *Journal* and other essential routine matters. I took a little more than two weeks away from the office as a vacation. This is the first opportunity I have had to put into words what has been in my mind and heart for some time to tell you in appreciation of your services as President of the AMERICAN CERAMIC SOCIETY.

As our president-elect, Mr. Eskesen, very aptly said, your occupancy of the chair gave it a prestige and a dignity far above that which it of late has had.

Your successful establishment of the Fellow grade of membership, and incidentally your very successful stopping of the organizing of the proposed Institute of Ceramic Engineers was a wonderfully well executed labor. You put into the organization of the Fellow membership classification ideals and aims and substantiality in character which no one, other than a person of your experience and ability, could have done. It certainly would not have been accomplished by anyone else in the SOCIETY at the present time nearly as effectively and successfully as you have done it.

The successful merging of the National Brick Manufacturers Association with the SOCIETY, creating the National Brick Research Foundation, was a task, as you know, on which several of us had labored, but all of whom had been defeated by prejudices which you alone could overcome.

Your representation of the SOCIETY at the Wedgwood Bicentenary was a matter of considerable importance to the SOCIETY. I am not forgetful of the thought, the time, the money, and the personal sacrifices which you invested in that trip, and in all things pertaining thereto. This SOCIETY is under great obligations to you on account of your services at the Wedgwood Bicentenary.

Your enthusiastic public statements in support of the definition of the relation of ceramic science and technology to sales and to trade, and the larger interests which must be had by the ceramic engineers, will influence not only the policies of the SOCIETY, but the policies of the ceramic schools. In this I believe you did a distinctive service.

The energetic and thoughtful manner in which you presented the need of unity in support by all ceramic industries of the Century of Progress in Ceramics in Chicago, 1933, was another worthy and valuable contribution by you as President of the SOCIETY. Your prestige, born of experience and of attainments, and of proved far vision, gave weight to your statements and advices which will be of beneficial influence in the efforts which we must continue to put forth if we are to have a successful representation of ceramics at the 1933 Chicago World's Fair.

I have mentioned only what appear to me to be the most important things which you did for the SOCIETY, and for ceramics in general, during your presidency. I am not unmindful of several other things, especially your presidential address. This is a letter, however, and it has its space limitations. I will not close without a word of personal appreciation of the privilege of having worked with you during the past year in the rather intimate relation of President and Secretary.

Yours very cordially,

ROSS C. PURDY, *General Secretary*

OBITUARY

Arthur E. Williams

Arthur E. Williams, formerly of Hartford, died Friday, February 13, in Lewistown, Mont., where he moved two years ago because of ill health, according to word received by William T. Barker, mechanical engineer at the Hartford Empire Company, where Mr. Williams was formerly employed for several years as a glass technologist. During the World War, Mr. Williams, who had devoted his life to the study of the glass industry from its chemical side, was with the Bureau of Standards in Washington. Mainly through his efforts, knowledge of lens glass formerly manufactured almost exclusively in Germany, was developed to the point where it could be produced in America. A much feared shortage of field glasses and telescopes for observation

work was thus averted. Besides his wife, he leaves two children, Arthur, 16, and Ruth, 14.

Resolutions Appreciative of Arthur E. Williams

The Board of Trustees of the AMERICAN CERAMIC SOCIETY, in regular session, during the Thirty-Third Annual Meeting in the Cleveland Public Auditorium, during the week of February 22, 1931, arose, and with silent thought unanimously approved the preparation of, and sending to the wife and children of Arthur E. Williams, the following Resolutions:

A. E. WILLIAMS

Whereas, the members of the AMERICAN CERAMIC SOCIETY had for several years the profit and pleasure of active coöperation of Arthur E. Williams in the capacity of an Active Personal Member, and as an officer of the Glass Division, and as a faithful worker on several committees, and

Whereas, his intelligent, cheerful, optimistic, and helpful attitude was consistently evident under all occasions, irrespective of the conditions of his health, or the complexity of the problems on which he was engaged, and

Whereas, his personal integrity, manliness, and unselfish brotherly love made him a close friend to all with whom he contacted, and

Whereas, he always lived and expressed loyalty to his family, to his professional associates, and to every cause which would advance our mutual welfare.

Be It Resolved, that we, Members of the Board of Trustees of the AMERICAN CERAMIC SOCIETY, speaking for the members of the SOCIETY at large, shall record an expression of the loss which we deeply feel, and

Be It Resolved, that we, believing in God's mercy and justice, feel that his removal from our midst shall cause us to take stock of those qualities of Arthur E. Williams which made him so effective in his work, and so endearing to his fellows, and

Be It Resolved, that we make record in the Proceedings of the SOCIETY, with copy to his immediate family, of our appreciation and deeply felt loss in the passing of Arthur E. Williams.

2525 N. High Street,
Columbus, Ohio,
February 22, 1931.

Mrs. Arthur E. Williams,
816 W. Evelyn Street,
Lewistown, Mont.

Dear Mrs. Williams:

The Passing of Arthur

Arthur won his way into the esteem of his fellows by virtue of his sterling character, by his independence, and by his very unusual perseverance and ever-ready willingness to coöperate and collaborate with his fellows. Arthur could always be depended upon.

It has often been wondered how far he would have gone if he had had good health. The grit and determination, and the ever-readiness to be up and doing, were a marvel to all of us who knew him.

I will never forget the day that he took me to your home in Elmira, when he was employed at Thatchers. He was proud of his home and his family. He grieved that he could not be more to them, and do more for them.

It must be comforting to you to realize that there are hundreds of people the world

over, but more particularly in this country, who have learned to know Arthur by his works, and many of them to know him personally, who will mourn with you. They will miss him. They honor him, and his name will not leave the pages of ceramic history.

Yours very sincerely,

ROSS C. PURDY, *General Secretary*

cc:
Francis C. Flint,
Hazel Atlas Glass Co.,
Washington, Pa.

J. T. Littleton,
Corning Glass Works,
Corning, N. Y.

Resolution

The Fellows of THE AMERICAN CERAMIC SOCIETY, assembled in their first meeting, held on February 22, 1931, at Cleveland, Ohio, are deeply grieved to learn of the departure of their beloved fellow member, Arthur E. Williams, and have authorized the adoption of the following resolution:

Be it resolved, that we give public expression of our sorrow in losing so valuable a member as was Mr. Williams, a man endeared to us by a most lovable nature and a truly heroic spirit, and honored for his fruitful service as a scientific worker. He has to his credit numerous achievements, among which his splendid service during the War in the production of optical glass, to which he sacrificed his health, is of outstanding importance. Modest, cheerful, energetic, and ever willing to serve, he was one of the pillars of this SOCIETY which ever had his deep affection and loyal assistance. The work of Mr. Williams will live on and we glory in the splendid record of his life.

Our friend was possessed of true courage with which he fought a long continued illness most heroically and with constant cheerfulness.

His memory will ever live with us and will be an inspiration to our membership.

Be it further resolved, that this resolution be spread upon the minutes of this Fellowship and that we convey to his family our deepest sympathy.

A. V. Bleininger
E. Ward Tillotson } *Committee*
S. R. Scholes

February 23, 1931.

Mrs. Laura M. Williams,
412 West Main Street,
Lewistown, Montana.

Dear Mrs. Williams:

The Fellows of THE AMERICAN CERAMIC SOCIETY, assembled in their first meeting at Cleveland, Ohio, on February 22, 1931, have learned with great sorrow of the departure of their brother, Arthur E. Williams.

We have a keen sense of having lost in him a courageous spirit, a man of the highest and finest type, a nature most sweet and lovable. The memory of his work and heroic service during the War, his remarkable example of fortitude and his inspiring companionship fill us with a sense of great loss. But he leaves behind him a memory of such fragrance that we are proud to have called him one of us and to know that his name will live on in the annals of this Fellowship as one of the most shining examples of a devoted and self-sacrificing scientist.

May we beg of you to let this feeling temper your sorrow. The work of your husband lives on and we glory in it. He leaves the world much richer for having lived in it.

By the authority of the Fellowship, assembled in formal meeting, we have been delegated to express to you and your family our deep sympathy in your sorrow. May your courage in this bereavement be equal to the superb courage shown by your husband. This is our sincere wish. We know what you have been to him and that you have been the fitting companion of such a choice spirit.

Yours very respectfully,

Signed { A. V. Bleininger
E. W. Tillotson
S. R. Scholes

REPORT OF COMMITTEE ON EXHIBITIONS, ART DIVISION

The Committee on Exhibition of the Art Division submits the following report:

The Craftsman Exhibit of the American Ceramic Congress held in Cleveland, Ohio, February, 1931, included the work of thirty craftsmen, seven schools, and three Settlement Houses.

A really contemporary exhibition was desired and work could be entered only if made within two years. For entrance, work was judged by the following jury:

Frank Sohn (*Chairman*), The Vitrolite Company, Chicago, Illinois.
Walter P. Suter, American Encaustic Tiling Co., New York, N. Y.
Arthur E. Baggs, Ohio State University, Columbus, Ohio.
Myrtle M. French, Art Institute, Chicago, Ill.

Awards of excellence, signed by the President of the SOCIETY and the Chairman of the Art Division were given as follows:

Vases	Arthur E. Baggs, Ohio State University, Columbus, Ohio. Charles M. Harder, N. Y. State School of Clayworking and Ceramics, Alfred, N. Y.
Bowls	Maija Grotell, Henry St. Settlement, New York, N. Y. Marion Lawrence Fosdick, New York State School of Clayworking and Ceramics, Alfred, N. Y.
Plates	Edgar Littlefield, Ohio State University, Columbus, Ohio.
Novelty Sets	Art Institute of Chicago, Chicago, Ill.
Tiles	Louise Kitchen, Toledo, Ohio.
Moldmade Objects of Utility	New York State School of Clayworking and Ceramics, Alfred, N. Y.
Ceramic Sculpture	Frances Johnson, Ohio State University, Columbus, Ohio.
Decorative Objects	Hull House Art School, Chicago, Illinois.

Frank Sohn and Walter Suter constituted the Jury of Award. Mr. Milliken of the Cleveland Art Museum was to have served but was unable to do so.

The effort of some of those manufacturers who entered work for the industrial exhibit was greatly appreciated, but although their work was displayed the group was not sufficient to warrant the granting of awards.

Respectfully submitted,
Marion L. Fosdick
Myrtle M. French
Charles M. Harder

MINUTES OF AWARDS COMMITTEE

The meeting was called to order by Chairman Helser in the Cleveland Public Auditorium on Monday, February 23, 1931, at 4:30 P.M. Messrs. Baggs, Silverman, and Trostel were also present.

The minutes of the previous meeting were read and interim correspondence which had taken place between the Chairman and Mr. Purdy.

Dr. Silverman suggested that the committee change its former stand of approval of a triennial award of one medal in each Division and that we recommend one annual award open to members of all Divisions.

A general discussion followed upon the objects of the awards, *i.e.*, were they to be as stimuli for papers or as recognition of especial distinction.

Following the discussion, which indicated that the Committee would not care to abandon its original stand on the triennial division awards, Dr. Silverman moved, seconded by Professor Baggs, that we re-submit our Minutes of last year to the Board of Trustees as the Committee's Report and that we request further instruction. The motion was carried.

The Chairman then read some correspondence from *Ceramic Age* referred to the Committee from Mr. Purdy, regarding prize essay contests on the subject of ceramics for students. *Ceramic Age* requested that the AMERICAN CERAMIC SOCIETY assist in selecting a jury to make the awards in case the idea itself met with the approval of the SOCIETY.

Discussion of the idea followed, resulting in a resolution moved by Dr. Silverman, seconded by Professor Baggs, and carried, to the effect that Mr. Purdy be advised that the Committee on Awards feels it best to confine its activities to SOCIETY awards only. The Committee, however, wishes to express its pleasure and compliments to *Ceramic Age* for offering this means of stimulating interest by students in the subject of ceramics.

The Committee adjourned at 5:30 P.M.

L. J. TROSTEL, *Secretary, pro tem.*

Committee on Awards:

P. D. Helser, *Chairman*
C. W. Parmelee
Alexander Silverman
Arthur E. Baggs
Homer F. Staley
Louis J. Trostel
R. L. Clare

Minutes of Meeting of Committee on Awards

The meeting was called to order Monday, February 17, 1930, at 2:30 P.M. at the Royal York Hotel, Toronto, by Chairman Helser.

Members of the Committee present were Messrs. Silverman, Parmelee, Staley, Baggs, and Trostel.

(1) The first item discussed was the type of paper for which the award was to be made. The Committee decided that the award should be limited to papers constituting an original contribution which had been accepted by the SOCIETY and published in the *Journal*. It was suggested that the Board of Trustees later make provision for a type of award not covered by the above case. This second type of award being of the sort generally referred to as "meritorious service."

(2) The second topic discussed was the question of limitations as to the persons who might receive this award. It was decided that neither sex nor nationality should be a bar. It would be necessary, however, that the author of the paper be a member of the SOCIETY. In the case of multiple authorship, separate medals may be awarded to each co-author.

(3) The only papers to be considered as being eligible for the award are to be such papers as have been published during the three-year period prior to the Annual Meeting at which the award is to be made. The Committee felt, however, that any paper which had been submitted to the *Journal* and was found too expensive to be printed but which was of especial merit should be referred to the Committee on Awards for their consideration.

(4) The award of the medal each year, in each Division, is not mandatory. This point was discussed in some detail and resulted in a motion by Mr. Staley, seconded by Professor Parmelee, that one medal may be awarded in each Division once in three years for an original contribution which has been published in the *Journal*. The first three-year period to start from January 1, 1930. The meaning of the word "original" was conceived to mean original in conception and not heretofore presented elsewhere in any other journal.

The motion was carried.

(5) The question of divisional juries was discussed and it was finally decided that such juries shall be chosen by the Fellows of the Division acting as a Committee. In the event that the Fellowship Plan should not mature the Awards Committee will make further recommendations.

(6) It was decided that a Certificate of Award should accompany the medal.

(7) The design of the medal was discussed in detail. It was the feeling of the Committee that the medal should be a large bronze one, about two and eleven-sixteenth inches in diameter, similar to the Garden Club sample submitted by the Medallic Art Company of New York City. The Committee plans to have on display at the next Annual Meeting, in Cleveland, the completed medal. Professor Baggs suggested as sculptor, Mr. Frey of the Ohio State University. Professor Baggs will handle the question of design through Mr. Frey.

The Committee decided that the medal shall be named "The Orton Medal of the AMERICAN CERAMIC SOCIETY," the medal to bear on its front face, an appropriate bas-relief of Professor Orton. The reverse side of the medal will be suitably stamped or engraved to show the divisional medalist and the year of award.

(8) The question of financing the medal was given consideration and from estimates on hand it appears that a fund of $2000 would not only care for the initial financing of the cost of sculptor's fees and die-plates but would also provide an endowment fund to yield about $50.00 a year which would care for the cost of striking off new medals. Actually, only about $1000 are needed to start the proposition and $50 per annum thereafter. The Committee expressed its willingness to coöperate further with the Board of Trustees if necessary in helping to raise the initial fund necessary to insure the success of the project.

The meeting adjourned at 4:00 P.M.

ENAMEL DIVISION REPORT OF BUSINESS SESSIONS

At a business meeting of the Enamel Division, AMERICAN CERAMIC SOCIETY, which took place in the Hotel Hollenden, Cleveland, Ohio, February 23, 1931, the following business was conducted. The subject under discussion was the past practice of the Division, as such, of annually accepting entertainment sponsored by individual organizations, and giving such entertainment official recognition. The opinion was offered by some members that these entertainment features had done much to augment the attendance of the Annual Meetings, to induce the plant executives to come, and to promote personal acquaintances among those interested in enameling.

Without disparaging the above-mentioned benefits, other members advanced the point of view that due to a "first-come-first-serve" policy, the same organizations were given the privilege of sponsoring these entertainment features year after year, a fact which was considered to be out of line with a uniform fairness of treatment toward all companies which are desirous of using this means of building good will.

After several expressions of appreciation toward the many supply houses which have given the Enamel Division their hearty support and coöperation, and have helped to bring the meetings to their present successful status, the following resolutions were duly proposed, seconded, and passed.

(1) *Be it resolved:* That out of a sense of fairness and uniformity of treatment toward all the supply houses interested in the Enamel Division, this Division is opposed to officially recognizing any function sponsored by an individual commercial organization, except in connection with plant visits.

(2) *Be it resolved:* That the Chairman of the Enamel Division appoint a committee to arrange for an Enamel Division Dinner at the next (1932) Meeting of the AMERICAN CERAMIC SOCIETY, that an admission fee be charged for this dinner, and that all plans made by the Committee shall be subject to the approval of the Division officers; further, that favorable consideration be given by this Committee to any offer made by the supply group, collectively to sponsor a program of entertainment during and/or following the dinner.

Respectfully submitted,

W. N. HARRISON,
Secretary, Enamel Division

Business Session, February 26[1]

Committee on Education[2]

The Committee on Education of the Enamel Division has worked directly with the General Committee on Education of the AMERICAN CERAMIC SOCIETY. A report was made in which the six resolutions which were proposed by the last Committee on Education of the SOCIETY were discussed, and finally four of those resolutions were adopted for recommendation to the ceramic schools.

The four resolutions were (1) that the Committee on Education of the AMERICAN CERAMIC SOCIETY recommends that at least 40% of the advanced courses should be devoted to fundamental sciences; (2) that at least 50% of it be devoted to other subjects; (3) that at least 4% of the ceramic curriculum be devoted to subjects dealing with business management; (4) that any school that wishes to give courses in enameling should have courses either concomitant or prerequisite in metallurgy and foundry practice, feeling that a man who wants to go into the enameling business should know something about the metallurgy of cast iron.

The fifth recommendation tries to specify what should be given as part of the ceramic course which deals particularly with ceramics. The sixth deals with the advisability of establishing five-year courses, and could not be brought to any conclusion, but was referred back to the committee for further consideration.

The question of the establishment of correspondence schools for ceramics has also been considered.

Research Subcommittee on Sheet Iron

B. T. SWEELY: Sometime last spring a number of us met to discuss this question. We thought that possibly a research fellowship could be established at some institution such as the Bureau, the Mellon Institute, or some of the universities, which would be supported by contributions from various individuals and corporations, to attack some of the problems on sheet-iron enameling such as those discussed in papers by Mr. Schaal.[3]

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[1] Stenographic notes of business meeting of the Enamel Division, Cleveland Meeting, February 26, 1931.

[2] For complete report of the Committee on Education, see *Bull. Amer. Ceram. Soc.*, **10** [4], 104 (1931).

[3] Mr. Schaal's papers which were presented before the Enamel Division and discussed, will be published this year in the *Journal*.

A questionnaire card was sent out from Mr. Purdy's office and thirty replies were received. The recipients of the card were to mark in numerical order the various defects which were listed, as well as the seriousness of the defect. For instance, if there was fishscale on the card and that was the worst defect the man had in his plant, he would mark that No. 1. If boiling or blistering were the worst, he would mark that No. 1. Of the cards returned, there were twenty-three on which the preferential numbers had been indicated. About ten cards had no marking on them. Two reported the phenomenal condition of no troubles whatever. And the others had no designation except that they had marked one or two defects as being present in their plant.

We listed these and found that the boiling or blistering defect led the others by three or four. The next most frequent defect seemed to be the hairline; I thought that we would find either fishscaling or copperheading the next most important. Copperheading was very close third.

We have written to a number of manufacturers to feel out the situation on the possibilities of financing a fellowship for the study of these problems. The responses were quite encouraging.

The plan which we thought might possibly be worked out was to try to get about forty subscriptions of $150 a year (a total of $6000) which would be enough to carry on this work, and to get the contributors to agree to give their support for a period of three years, since the problems could not be solved in one year.

We hoped to continue this work, but unfortunately we struck this worldwide depression and the present time does not seem to be propitious to raise the required money. But there is a strong possibility that we can get the fellowship financed. The committee has done nothing beyond making a survey of the possibility of carrying on the work.

Research Subcommittee on Cast Iron

M. E. MANSON: The Bureau of Standards has spent many thousands of dollars (between $20,000 and $30,000) on this research and has decided that it cannot afford to proceed on the same basis any longer. It also seemed impossible to attack the problem at the various plants, and as Mr. Sweely has said, the present time is not auspicious for raising money.

The University of Wisconsin was suggested as the place to conduct the research on this problem when the money to carry it on is available. The Dean of the Metallurgical School, Professor McCaffery, has done some fine research work in connection with outside metallurgy, particularly on blast-furnace problems. He has secured some amazing practical results and the laboratories are well equipped, probably the most complete metallurgical laboratory in the world.

Mr. Cooke and I interviewed Professor McCaffery, who said that he was familiar with the problem, that is, he has read the complete Bureau of Standards report. He thinks that the problem is promising and is confident that it can be solved. The fellowship to handle the research would cost about $5000 a year.

Mellon Institute, Battelle Institute, or a return to the Bureau of Standards are also suggested as places to conduct the research on this problem.

Report of Committee on Research

R. R. DANIELSON: Mr. Poste has submitted a report as treasurer of this Committee, showing that there is a balance of $800 left in the funds from the sum originally collected. That money is in the bank and is earning money every year whether we have any action or not.

The money was originally collected with the understanding that it would be used for cast-iron research, and it is being retained to be devoted to that service when it is needed.

E. P. POSTE: Other Divisions of the SOCIETY have established definite research

funds or research organizations, but with a permanent status, rather than for a specific problem. It might be well to investigate the methods of these Divisions to determine whether or not a kind of continuous research organization, auxiliary to this Division could be arranged, rather than to collect money for specific problems only. That would give a continuity to the work, especially if members were elected each year, with some holding over for two or three years.

The Glass Division has such an organization, as well as the Refractories Division, and the Structural Clay Products Division in its present scheme in taking over another organization, is establishing a National Brick Manufacturers' Research Foundation with an identity as a financial organization.

R. D. LANDRUM: I move that we leave this matter in the hands of the Research Committee and that a report be made next year.

Committee on Data A. I. ANDREWS: The Committee on Data has not done anything as a body. H. D. Carter reported that he and Mr. Landrum had been working on the Enamel Bibliography, bringing the material up-to-date.

R. D. LANDRUM: There are 500 pages completed on the Bibliography. Each one of them has an abstract, something published on enameling during 1928 and 1929. Mr. Carter and I hope to continue with this work. If at any time there is any demand for it, it will be in such a shape that it can be used. This is being kept in the same form as the original Enamel Bibliography (published in May, 1928), alphabetical as to author and subject.

The report of the Committee on Standards was read by Mr. Cooke.

MINUTES OF A MEETING OF THE REFRACTORIES DIVISION[1]

February 24, 1931, Hotel Cleveland, Cleveland, Ohio

C. F. Geiger, Chairman, conducted this Annual Meeting of the Refractories Division. Mr. Geiger called for divisional committee reports in the following order:

Program Committee R. B. Gilmore, Chairman, had no report to make at this time.

Membership Committee C. E. Bales read the report of the Membership Committee, in the absence of J. L. Crawford, Chairman:

On April 12, 1930, the membership of the Refractories Division was as follows:

Individual members	470		
Professors	50		
Total individual members		520	
Companies	43		
Total companies		43	
Total individual members and companies			563
Since that time we have added the following:			
Members of the AMERICAN CERAMIC SOCIETY not previously classified	18		
New members (individuals)	35		
Total individual members		35	
New members (companies)	2		
Total companies		2	
Total new members			55
			618

[1] Submitted by the Secretary-Treasurer of the Refractories Division, March 17, 1931.

Members dropped	6	
Members resigned	3	
Total		9
Total (companies and individuals) as of February 1, 1931		609

Publications Committee L. J. Trostel, Chairman of the Publications Committee, read the following report:

(1) *Papers Reviewed:* The Secretary's office of the Parent SOCIETY directed fourteen papers to the Committee for review. This lot consisted largely of such papers as were on file for publication at the time the Committee was formed, several months following the Annual Meeting of the SOCIETY. Of these, seven were reported acceptable and the remainder rejected for various reasons. Five of the acceptable papers have been published. All of the changes suggested by the Committee were complied with.

Rejection of papers was based largely on the previous publication of a substantial part of the subject matter in other journals, lack of novelty of the subject, or insufficient and inconsistent supporting test data.

The Committee at all times has been inspired by a desire to be helpful to authors and to encourage them to publish in the *Journal* as the proper medium for the dissemination of ceramic knowledge, but at the same time setting a high standard and maintaining an attitude sufficiently critical to insure that the papers finally approved would be worthy of the *Journal* and justify the existence of the Committee. The mortality of papers may appear high at first but the effect is bound to be salutary and will make authors review their own papers more critically before submitting them for publication.

(2) *Policies Established:* Four matters of policy were acted upon during the year:

(*a*) The Committee advised the Parent SOCIETY Secretary that it did not favor a concentration of refractories papers in a few issues a year since it was felt that this would narrow the interests of the Refractories Division readers and detract from general interest in the SOCIETY. It was felt further that papers are more thoroughly read and digested if not bunched but rather distributed over the twelve months.

(*b*) The Committee took the stand that it would not be observing the wishes of the Division if it did not review all papers bearing on refractories, whether papers which had been presented before the Division or submitted for publication between Annual Meetings. The Parent SOCIETY Secretary's office was so advised.

(*c*) The Committee has discussed the question of whether it should review papers before presentation at the Annual Meetings as stipulated in the By-Laws, as well as review those intended for publication. We are in agreement on the basic idea that papers for the Annual Meeting should be reviewed by someone. The opinion is that it should be the Program Committee.

(*d*) In order to not disrupt the work of the Committee by a complete change in personnel annually, the Rules Committee was requested to submit a By-Law to the Division recommending that of the three committee members, only one, the Chairman, retire each year and that the senior member of the remaining two be the next Chairman.

(3) *Coöperation with Journal Editor:* We take this occasion to thank the *Journal* Editor for a most whole-hearted coöperation during the year. We have recognized that joint responsibility exists between the Editor and the Committee as to the eventual form in which papers appear in the *Journal*. The Committee has left to the Editor largely the editing of the form in which the paper shall appear and has reserved to itself mostly the privilege of criticizing the substance of the paper for accuracy, though reserving the right to criticize detail of form whenever this was felt necessary. The Committee in every case has reviewed the authors' original manuscript, showing the Editor's changes, and this we feel should be continued, to permit a check or review of editing of form which at times affects the meaning of the subject matter in a manner which may escape the Editor.

Committee on Research The Committee on Research, of which Donald W. Ross is Chairman, submitted the following report:

(1) *Policy:* When organized in 1929 the duties of this Committee, as understood by the Committee itself, were to aid and encourage research on refractories. In accordance with our own views, since its inception, the policy of this Committee, backed by the opinion of the Executive Committee, has been to aid the present sources from

which new information may be expected, rather than to solicit money and start research under our own auspices.

(2) *1930 Work:* To this end the Committee report for 1930 consisted of a list of the sources from which new information on the subject of refractories can be expected, together with general outline of a number of the principal research problems on refractories, which are at present awaiting solution.

(3) *1931 Work:* At the start of the present year's work the Committee concluded that additional sources of new information on refractories could be developed by interesting research departments of colleges and universities in high temperature research. Hence, our first activity was to distribute copies of our 1930 report, together with outlines of several additional research problems:

(*a*) To all addresses given in the report
(*b*) To twenty-five Graduate Schools of Physics
(*c*) To twenty-six Graduate Schools of Chemistry
(*d*) To twenty-four Graduate Schools of Geology
(*e*) To one hundred twenty-nine Engineering Schools

(4) *Collecting Pertinent Information:* As our work has progressed we have come to the conclusion that we could aid research on refractories by collecting certain information and transmitting it to those who are doing or might undertake research on refractories. As a part of this work R. B. Sosman has prepared an article entitled "High Temperatures as a Field for Physico-Chemical Instruction," and R. A. Heindl has prepared some preliminary remarks on "Types of Apparatus Suitable for Fundamental Studies on Refractories." Mr. Heindl expects eventually to develop this subject more fully.

(5) *Exact Control of Furnace Temperatures and Atmospheres:* There appears to be special need for wider dissemination of knowledge concerning the desirability of and means of obtaining exact furnace temperatures, and of accurately controlling the atmospheres in test furnaces. Vance Cartwright is undertaking the preparation of a preliminary paper on "Control of Test Furnace Atmospheres."

(6) *Error of Measurements:* This Committee is also greatly impressed with the apparent general lack of analysis of ceramic data from the standpoint of the "probable error of measurements," which leads to a lack of the true significance of recorded measurements.

(7) *Future Work:* In conclusion, this Committee suggests that next year's Committee continue the work on types of apparatus suitable for fundamental studies on refractories, that it collect and record suitable methods for mathematically analyzing ceramic data, and that it again review the subject matter of research problems, dividing the larger problems into more exactly outlined small units. At the present time this Committee has at hand a limited amount of information as to researches which are being carried on or contemplated. We suggest that next year's Committee continue collecting such information, and from time to time publish lists of such work insofar as practicable.

Rules Committee Donald W. Ross, Chairman Rules Committee, reported as follows:

(1) Your Rules Committee has no changes in the By-Laws to suggest at this time, although some revision of rules is under consideration.

(2) The scanning of papers prior to their presentation before the Refractories Division is not yet in full operation. This may or may not require further change in the By-Laws, consequently your committee has this matter under advisement.

(3) Further, it has been suggested that election of officers take place by letter ballot before the Annual Meeting so that the new officers can get their committees appointed and their administration functioning during the Annual Meeting.

(4) Your Committee recommends that these two matters be developed to their logical conclusions by discussion during this Cleveland Meeting.

Committee on Standards Stuart M. Phelps, Division representative to the group on Standardization of Tests, Committee on Standards, had no report to make.

C. E. Bales, division representative to the group on Standardization of Products, Committee on Standards, had no report.

General Committee on Research Donald W. Ross, Division representative to the General Committee on Research of the AMERICAN CERAMIC SOCIETY, announced that this committee has made no recent report.

Committee on Data A. E. R. Westman, Division representative to the General Committee on Data of the SOCIETY, had nothing to report at this time.

Committee on Ceramic Education M. E. Holmes, Division representative to the Committee on Ceramic Education, announced that the following resolutions have been prepared by this Committee:

I. Resolved: That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that every curriculum in ceramic engineering or ceramic technology should contain, as a minimum, 40% of the total credit hours in the fundamental sciences.

II. Resolved: That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that every curriculum in ceramic engineering or ceramic technology should contain, as a minimum 15% of the total credit hours in cultural subjects.

III. Resolved: That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that every curriculum in ceramic engineering or ceramic technology should contain, as a minimum, 8% of the total credit hours in subjects dealing with business and management.

IV. Resolved: That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that instructions in ceramic technology in four-year curricula be, when possible, confined to the technology of clay products (including special bodies and special refractories), or, the technology of enameled ware or the technology of glass.

V. Resolved: That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that schools wishing to offer instruction in one curriculum in more than one of these three main divisions of ceramic technology extend the length of the curriculum to at least five years.

VI. Resolved: That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that no course in enameling technology be offered unless courses in foundry practice and metallurgy of iron and steel are given as prerequisites or concomitants.

VII. Resolved: That the foregoing six resolutions are to be considered as tentative recommendations and are to be submitted to the ceramic schools for discussion and revision during the next twelve months, and will be brought up for final action at the next Annual Meeting of the SOCIETY.

Copies of these resolutions have been sent to the various ceramic schools. They have been studied by the staff of the various schools and formal statements have been sent to the committee by each of the schools. The Committee is now engaged in studying these communications but as yet has taken no definite action.

Exhibitions Committee In the absence of A. F. Moranty, Chairman of the Exhibitions Committee, J. Spotts McDowell read the report prepared by Mr. Moranty:

The question of a general exhibit of refractories, similar to that planned by the Art Section, was discussed with H. S. Wilson, the one other member of this Committee. It was decided that it would be extremely difficult to arrange an exhibit that would be of interest to the general public and at the same time be of some value to the participants. As this was the general opinion of others with whom the matter was discussed, the project was dropped without further action.

Election of Officers The Committee on Nominations, composed of E. H. Van Schoick and Geo. A. Bole, presented the following nominations for officers of the Refractories Division:

Chairman,	A. E. R. WESTMAN
Vice-Chairman,	R. B. GILMORE
Secretary-Treasurer,	DOROTHY A. TEXTER
Nominating Committee,	C. F. GEIGER
	L. J. TROSTEL

In addition to these nominations, the following members of the Division placed the name of Sandford S. Cole in nomination for Chairman: Robert F. Ferguson, Don C. Lynn, Robert H. H. Pierce, Norman Stolte, Stephen M. Swain, and George J. Bair.

The Chairman appointed M. E. Holmes and J. Spotts McDowell to be tellers, who reported the following officers elected by ballot for the year 1931, in accordance with the provision for Election of Officers in the By-Laws of the Refractories Division.

Chairman, A. E. R. Westman
Vice-Chairman, R. B. Gilmore
Secretary-Treasurer, Dorothy A. Texter
Nominating Committee { C. F. Geiger, L. J. Trostel

SUPPLEMENTAL REPORT OF COMMITTEE ON GEOLOGICAL SURVEYS[1]

The Committee on Geological Surveys had charge of the general meeting at the Cleveland Meeting Monday afternoon, February 23, 1931.

Five papers of a geological character were scheduled and presented as follows:

"Ceramic Shales of Georgia," by R. W. Smith, Asst. State Geologist of Georgia, presented by A. V. Henry.

"Petrographic and Mineralogical Study of the Underclays of Illinois Coal," by Victor T. Allen, St. Louis University.

"Some Ceramic Resources of Virginia," by Arthur Bevan, State Geologist of Virginia (read by title only).

"Adhesion, Tension, and Effect of Electrolytes on Clays," by George Whitlock, Dept. of Geology, University of Indiana (read by title only).

"Geology of Some Oklahoma Clays," by Leonard Sheerar, Agricultural and Mechanical College, Stillwater, Okla. (read by title only).

Donald Ross, Findlay Clay Products Co., Washington, Pa., suggested that a tabulation of the geological formations in which refractory clays are found in different parts of the country would be of much assistance to the ceramist, especially for preparation of papers on any particular operation.

The Chairman explained the aims and work of the Committee as interpreted by the Committee members, as collecting information about the work that the State and Federal Surveys are doing of particular interest to the ceramic industry and lending encouragement and help whenever possible to these agencies. The advantage to be gained by making use of the state surveys when searching for new sources of ceramic materials was also pointed out.

Committee on Geological Surveys,
W. M. WEIGEL, *Chairman*

NEW MEMBERS RECEIVED IN MARCH

CORPORATION

Benjamin Electric, Ltd., Brantwood Works, Tariff Rd., Tottenham, N. 17, England.

PERSONAL

William Eitel, Faradayweg 16, Berlin-Dahlem, Germany; Director, Silikate Institute of the Kaiser Wilhelm Gesellschaft.

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[1] For Report of Committee on Geological Surveys for 1930 see *Bull. Amer. Ceram. Soc.*, **10** [2], 35 (1931).

Arthur L. Koch, Box 573 K, R. R. 1, Rivera, Calif.; Chemist, Pacific Clay Products.
Frank W. Preston, Standard Mfg. Co., Butler, Pa.
Herbert F. Royal, 1047 Madison Ave., Birmingham, Mich.; Chief Chemist, Champion Porcelain Co.
W. C. Rueckel, Ohio State Univ., Engineering Experiment Station, Roseville, Ohio.
John Salt, Villa Ludwig, Hemixem-lez-Anvers, Antwerp, Belgium; General Manager, Manufactures Céramiques d'Hemixem.

STUDENT

Franz Görner, Fr. Wiesner, Eisenstein (Bohemia), Czechoslovakia.

Membership Workers' Record

CORPORATION		PERSONAL	
Office	1	F. A. McCann	1
		C. W. Parmelee	1
STUDENT		F. H. Riddle	1
Office	1	Office	3
		Total	6
		Grand Total	8

ROSTER CHANGES IN MARCH

CORPORATION*

Moore & Munger, Melville Marks (voter), 33 Rector St., New York, N. Y. (29 Broadway.)

PERSONAL*

Berkman, A. S., Nevski Prospect 21, c/o Soiuzsteklofarfor, Leningrad, U. S. S. R. (53 Park Place, New York, N. Y.)
Brebner, F. D., Leonard Refrigerator Co., Grand Rapids, Mich. (Membership transferred from A. D. McCaughna.)
Davis, H. S., c/o Laclede-Christy Co., Box 202, Rochester, Pa. (5078 Washington Ave., St. Louis, Mo.)
Hughes, Tom E., Ambassador Apts., Pittsburgh, Pa. (1251 Commonwealth Ave., Boston, Mass.)
Kovacs, John, Mountainside Art Pottery, Mountain Ave., Mountainside, N. J. (21 Russell St., Vauxhall, N. J.)
Lee, P. William, American Terra Cotta & Ceramic Co., Crystal Lake, Ill. (6966 Hilldale Ave., Chicago, Ill.)
Meyer, Herbert T., c/o L. J. Meyer, 247 N. Indiana Ave., Kankakee, Ill. (Porcelain Enamel & Mfg. Co., Baltimore, Md.)
Reinecker, F. O., Wolff Co., 2057 West Fulton St., Chicago, Ill. (Membership transferred from W. T. Mahoney.)
Slaven, S. J., 590 Rogers Ave., Brooklyn, N. Y. (The Abrasive Co., Philadelphia, Pa.)
Stevens, Frank J., 414 Prospect St., Nutley, N. J. (1606 Avery St., Parkersburg, W. Va.)
Tefft, T. D., Claycraft Mining & Brick Co., Columbus, Ohio. (813 N. Chicago Ave., South Milwaukee, Wis.)
Waltman, William D., 601 Edison Bldg., 5th at Grand, Los Angeles, Calif. (551 Fifth Ave., New York, N. Y.)
Wassman, John R., 511 North Pearl St., Joplin, Mo. (4608 Dover St., Chicago, Ill.)
Windsor, B. R., Colchester, Ill. (Old Virginia Brick Co., Salem, Va.)
Zehm, Robert C., The Stevenson Co., Wellsville, Ohio. (45 W. Dunedin Rd., Columbus, Ohio.)

* Addresses within the parentheses ( ) represent the old address.

These Roster Changes which are published each month may be checked against the complete Membership Roster which appeared in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

LOCAL SECTION NEWS

Pittsburgh Section[1]

The Pittsburgh Section of the AMERICAN CERAMIC SOCIETY will be the guests of the East Liverpool Ceramic Engineers' Club at a meeting and inspection trip to be held in East Liverpool on May 12. After assembling at the Travelers Hotel at 2:00 P.M. the group will visit the plants of the Hall China Co. and the Patterson Foundry and Machine Co. Following the inspection trip, dinner will be served at the hotel with a program of addresses and music. The ceramic department of the East Liverpool High School has prepared souvenirs for the guests. Arrangements are in charge of H. B. DuBois and other members of the club.

Pacific Northwest Section[2]

The third meeting for 1931 was held Tuesday evening, March 31 at the University of Washington. Dinner at the University Commons was followed by an informal discussion of clay products, their uses, abuses, and future prospects. Three interesting moving pictures were shown:

(1) "The Manufacture of Glass Tank Blocks and Pots," by the Buckeye Clay Pot Company, Toledo, Ohio.

(2) "The Manufacture and Uses of Carbofrax Refractories," by the Carborundum Company of Niagara Falls and Perth Amboy.

(3) "The Manufacture of Pottery," Henry Ford Educational Film. Sixteen persons attended the dinner and 36 were present for the pictures.

St. Louis Section

Members of the St. Louis Section visited the plant of the Owens-Illinois Glass Co., Alton, Ill., on March 21. J. W. Wright was Chairman of the arrangements for this meeting. Frederick E. Bausch is Chairman of the St. Louis Section and Wallace Thoreson is Secretary.

A CENTURY OF PROGRESS IN CERAMICS

1933 Chicago Centennial Exposition

Expositions are not new enterprises.

According to the Book of Esther, King Ahasuerus held an exposition at Shushan to show "the riches of his glorious kingdom, and the honor of his excellent majesty, many days, even a hundred and four score days."

Records exist of 2800 grants of franchises for expositions in England between the years 1199 and 1483.

The first modern exposition was held in London in 1756 under the auspices of the Society of Arts. There were 540 exhibitors in the 1802 Paris Exposition. Educational expositions by countries, states, counties, and by industries for centuries have increased in number and interest in spite of the increasing facilities for travel and for broadcasting information.

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[1] Robert F. Ferguson, *Chairman*.

[2] Hewitt Wilson, *Secretary*.

Expositions of products are increasing in numbers because analytical business men for centuries have realized and are realizing more certainly that expositions stimulate trade as will no other activity.

Trade exhibits to jobbers and buyers, and exhibits of special lines to limited groups such as exhibits of tile to tile contractors and jobbers, of hotel glass and china to hotel managers, are strictly sales showings of new treatments or designs to those who are already well informed of the capacity of the producer to produce. These are not public showings. They are not educational in character or interest.

Permanent exhibits, open and advertised to the public are more educational in purpose, yet they also are primarily trade exhibits.

The periodical expositions of galleries and by societies are strictly educational in purpose; and such are our modern state and county fairs.

National magazine advertising and radio broadcasting are primarily of educational intent and effect. They reach the general public: the ultimate buyer. The result wanted is to create a demand that will be made on those who sell to the public, the middleman.

That one of the purposes of educational expositions is trade promotion, there is no question. This purpose is the most obvious and to the sales manager it is the one habitually foremost.

But of far greater value to the manufacturers in these public expositions is the general education alike to the producers and users that results indirectly and directly in industrial development and progress.

The story of the awakening and consequent development of the victrola industry after its business had dwindled to almost nothing holds a lesson in industrial product development that argues for educational expositions.

The manufacturer and the industry that is not aware of the production benefits, as well as trade stimulation, which result from public educational expositions has not learned the lessons of the centuries as to how industries have developed and grown.

One man or one organized corporation of men cannot originate or work out the successful application of all the changes in materials, equipment, processes, or products that are necessary to keep his product in successful competition. For too long a while, ceramic manufacturers of clay, of glass, and of vitreous enamel products have failed to cultivate the public sources of information and inspiration from which the more progressive and successful industries have drawn so heavily.

The Chicago Centennial Exposition in 1933, showing a century of progress, is an educational enterprise in which every ceramic industrial group must participate. For trade reasons? Yes: but also for the more beneficial purposes of educating the public and ourselves to the unknown possibilities in ceramic product development and in ceramic product use.

NOTES AND NEWS

AN EXPERIMENT IN THE HANDLING OF TECHNICAL SOCIETY MEETINGS

Meetings of technical societies are often wearisome and irritating because the programs are crowded, and the authors use so much time in presenting their papers that none is left for discussion. In order to make the printed transactions most useful for reference, the number of papers should increase rather than decrease, but to allow discussion, which is often more valuable than the paper that produced it, some means must be found to diminish the time taken in presentation of papers.

An attempt to solve this problem will be made at the June meeting of the American Society for Testing Materials (June 23, Hotel Stevens, Chicago), at which two sessions will be devoted to a joint Symposium of the A.S.T.M. and A.S.M.E., on the engineering problems involved in the use of metals at high temperatures. The Symposium will deal with the engineering trends in the needs of the power plant, oil, chemical, metal, automotive, and ceramic industries for metals for high temperature service, and with the properties of available materials for such service.

The alloys whose properties will be described comprise not only the special heat-resistant alloys of the nickel-chromium-iron type, but also, other nickel, chromium, rare metal, nitrided steel, etc., alloys available for high temperature use.

As much stress will be laid on the high temperature properties of the ordinary materials of engineering construction, such as wrought carbon and low alloy steels, cast steel, cast and malleable iron, copper alloys, zinc alloys, aluminum alloys, and bearing metals, as on those of the special alloys. Other papers will discuss the mechanism of failure at high temperatures, low-temperature properties of metals, and the subjects of thermal expansivity and thermal conductivity. The authors are all authorities in their fields.

There will be nearly 30 papers, but their authors have written them with the express understanding that no author is to present or even to summarize his own paper. The high spots of all the papers on the Engineering Needs of the Industries will be summarized at the first session by a representative of the Joint Committee of the A.S.T.M. and A.S.M.E. on the Effect of Temperature on the Properties of Metals. This Committee is sponsoring the Symposium. Another representative of the Committee will summarize the papers on the Properties of the Various Alloys for the second session.

Neither representative has written any of the papers, and their task is to set forth a general picture of the engineering situation as it is brought out in the individual detailed papers. The subjects will then be thrown open to discussion, with the authors ready to answer questions.

It is thus hoped to combine the advantages of giving, for reference, a complete picture of the engineering situation in the printed transactions, with active and interesting discussion at the meeting itself. If the plan works, it should offer a way out of the boredom of many over-crowded technical meetings.

The papers must be preprinted and in the hands of the members and guests who will wish to discuss them, well in advance of the meeting. This is being arranged for and those who are interested in discussing high and low temperature needs for and properties of metals may obtain a copy of the preprints from C. L. Warwick, Secretary, A.S.T.M., 1315 Spruce Street, Philadelphia, about May 10.

THE 1931 CERAMIC EXPOSITION AT RUTGERS UNIVERSITY

The second Ceramic Exposition was held at Rutgers University, New Brunswick, N. J., under the auspices of the Rutgers Ceramic Club, a student organization, from March 17 to 21, inclusive.

A wide range of exhibits, including early New Jersey pottery and glass and the most modern products of ceramic manufacturers in the State, was on display.

The early New Jersey pottery and glass were displayed through the courtesy of Mr. and Mrs. Hugh Williamson Kelly, of Woodbridge, N. J. Included in the exhibit was a "Wistarberg" bowl made during the period 1738–1770. Wistar was a pioneer South Jersey glass manufacturer. Other pieces in the same exhibit included vases and

pitchers of deep blue glass, pitchers of light glass with lily-pad decorations, etc. The glass bottles exhibited included one of the original "Booz Bottles," a "Baltimore Monument" bottle, and a dark blue calabash bottle with imprint of George Washington on one side. A blown glass tumbler inscribed "Welcome Lafayette," made in honor of General Lafayette on the occasion of a banquet tendered him by General Gates at York, Pa., was also exhibited.

Among the early pottery shown was an "Ellsworth Pitcher," modeled in commemoration of the shooting of Col. E. E. Ellsworth at Alexandria, Virginia, during his attempt to tear down the Confederate flag from a building on which it had been hoisted. Various other pitchers, a tea set made by the Jersey City Pottery Co., pie plates, foot warmers, crocks, etc., all of early New Jersey manufacture, were shown.

The Federal Seaboard Terra Cotta Corporation and Atlantic Terra Cotta Company displayed sections of terra cotta used in the construction of some of the largest buildings recently erected in New York and other large centers of population.

Sayre & Fisher Brick Company, Sayreville, N. J., exhibited a miniature "shingle brick" house, flanked with photographs of huge sky scrapers and other buildings in which this company's products are employed. Other brick manufacturers, including the American Enameled Brick Company and the National Fireproofing Company had exhibits. The New York and New Jersey Clay Products Company of Sayreville exhibited a line of hollow clayware. A photograph was displayed of the new Empire State Building in New York City, in which the products of this company were utilized.

The National Fireproofing Company and the Anness Hollow Tile Co. had a display of their products.

Manufacturers of refractory products of all kinds were represented by M. D. Valentine & Brother Company, Superior Fire Linings Co., Johns-Manville Corp., Henry Maurer & Son, Seaboard Refractories Company, Sayre & Fisher Company, and the Carborundum Company.

With the floor and wall tile manufacturers the Mueller Mosaic Company showed unusual effects in faience tile. A colorful parrot, one of the products of the Pardee-Matawan Companies, was shown on the wall above the fire-place in the assembly room. Other modern tile panels depicting floor and wall tile treatments, garden fountains, novelties, etc., were placed on display by the Robertson Art Tile Company, Mosaic Tile Company, Whitehead Pottery Company, Progressive Art Tile Company, Pardee-Matawan Tile Companies, Crescent Tile Company, and the New Jersey Tile Company. The Robertson Art Tile Company, through the use of their Panelier, showed the color effects possible with modern wall tile.

Lavatories were shown in pastel shades, the product of the Trenton Potteries Company. Laundry trays in color and plain white by the Fords Porcelain Works and the Woodbridge Ceramic Corporation were of great attraction to the housewife.

Built-in plumbing fixtures, etc., in a wide range of color and shape were placed on display by several manufacturers. These included the Trumbull Electric Company, Willette Corporation, Mitchell-Bissell Company, Cook Pottery Company, and Whitehead Pottery Company.

The Scammell China Company, Trenton, had an exhibit of plates and special services on display, including the ware being supplied by this company for the new Waldorf-Astoria, New York City.

The exhibit of Lenox, Inc., was one of the centers of attraction. The new "Apple Blossom" pattern was a favorite, and the Washington-Wakefield and Harwood patterns, assorted service plates, and beautiful statue lamp were also shown.

Decorated china and glassware in the exhibit of Edmundson Warrin, Inc., New York and Upper Montclair, N. J., were pleasing to visitors.

Scientific glassware from the Kimble Glass Company, Vineland, was displayed in the chemistry laboratory of the Ceramics Building. Bottles of all types were featured by the Salem Glass Company. The General Electric Company displayed a line of fused quartz specialties.

Electrical porcelain ware of all kinds, textile and silk mill porcelains, made for the most part in the Trenton district, were exhibited by the Cook Pottery Company, Mitchell-Bissell Company, Star and Frenchtown Porcelain Companies, Trumbull Electric Company, and the Imperial Porcelain Company. The latter company featured a display of high-tension porcelain of numerous shapes.

The National Porcelain Company displayed pyrometer tubes in a variety of sizes. The General Ceramics Company of Keasbey had an exhibit of chemical stoneware specialties and electrical and gas fixtures.

Colorful pottery exhibits of the Mountainside Art Pottery and the Stangl Pottery were shown and Mr. Kovacs of the Mountainside Art Pottery made pottery each day on the potter's wheel.

A glass blower was also present to give an exhibit of his work.

Among the materials companies and clay companies exhibiting were the Consolidated Feldspar Corporation, Eureka Flint and Spar Company, Edgar Brothers Company, Hampton Cutter Clay Mines, United Clay Mines Corporation, Enterprise White Clay Company, Whitehead Bros. Company, and the Roessler & Hasslacher Chemical Company. The latter company exhibited a line of ceramic colors with many appropriate test pieces showing the effects possible by the use of its products.

The miniature clayworking machinery was installed by the Crossley Machine Company, Trenton.

A miniature tunnel kiln, electrically operated, was placed on display by the Swindell-Dressler Corporation.

The American Gas Association exhibited a series of test pieces showing the results of some of the work being conducted at the Ceramic Department in connection with the Industrial Research Project No. 11. This involved the direct-firing of whiteware in gas furnaces.

A dinosaur foot-print removed from the Hampton Cutter Clay Mines was viewed with great interest by visitors to the Exposition. The foot-print which is one of several found in the Cutter pits, is estimated to be more than sixty million years old.

Arrangements for the Exposition were in charge of Professor George H. Brown, Director of the Department of Ceramics, assisted by his staff and students.

Students were engaged in laboratory work which illustrated the various processes in the manufacture of ceramic products. They also acted as guides for visitors to the Exposition.

What the Carborundum Company Recuperators are Doing in a Noted Glassware Plant . . .

TO reverse the usual order and begin with a summary, these recuperators are saving $4680.00 per year on three glassware units.

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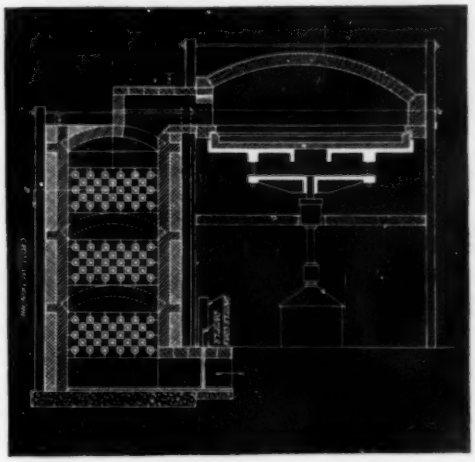

Each of the three recuperators utilizes banks of tubes made from "Carbofrax"—the "Carborundum" Brand Silicon Carbide Refractory. The tubes are 52 inches long, ⅞ inch thick walls.

The high thermal conductivity of "Carbofrax" and its remarkable refractoriness are responsible for years of operation with no recuperator maintenance charges and the reduction of flue gas temperatures from 1775° F. entering the recuperator to 650° F. at the stack.

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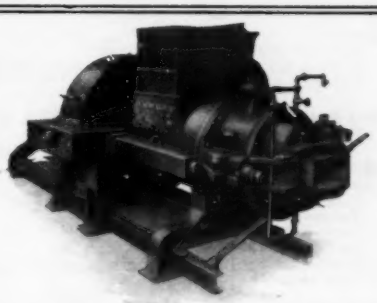

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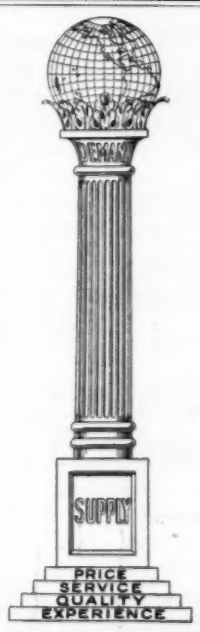

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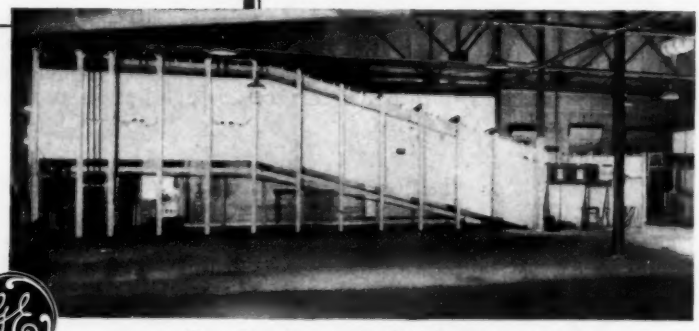

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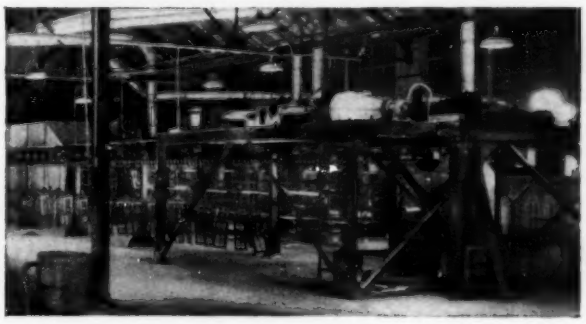

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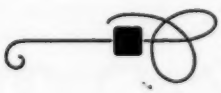

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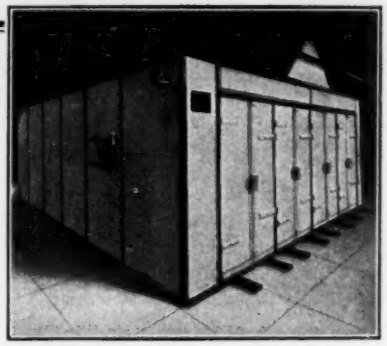

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